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SOME FACTORS IN THE INSTITUTE'S SUCCESS[1]

IT is fifty years to-day since Governor Andrew signed the charter of the Massachusetts Institute of Technology. There are many in the community who have watched the growth of this institute ever since. The dean of those who have been intimately associated with its government is Mr. William Endicott—a tireless worker in its interest. He writes to express regret that he can not be with us to-day, on account of a recent family bereavement, and adds: "It has been one of the greatest pleasures of my life to watch the Tech's triumphant progress from small beginnings to its present assured position as one of the leading scientific institutions of the world." In spite of (perhaps, because of), its youth, and in spite of (if not because of) its earlier struggles and difficulties, it is now absolutely in the front rank—a recognized leader in its chosen field, held in respect and honor everywhere. Why this conspicuous success? It is a question that has often been discussed in the reports of commissioners and other distinguished visitors from abroad, and in the councils of educators at home. Many are the explanations offered—the earnestness and devotion of the faculty, the spirit and energy of the students, the loyalty and organization of the alumni, the completeness of its equipment, the number and distinction of its instructors, the variety of its courses, the thoroughness with which the students'

[1] Address by the president of the Massachusetts Institute of Technology at opening of the Congress of Technology, April 10.

knowledge and ability is tested, the practical character of the instruction, the close touch with industries, the power of adaptation and resources manifested by its graduates, and so forth. These are doubtless all contributory causes and are the causes that naturally suggest themselves to a student not specially versed in the history of the institute.

At this season, when we are celebrating the fiftieth anniversary of its chartering, it seems natural to lay somewhat more emphasis on historic causes.

The more one looks into the matter, the more is he impressed by the fact that although many enlightened men cooperated in launching the institute on its course, the enthusiasm and the guiding power were supplied by one man—Rogers. His choice of Boston as a suitable place for the new venture was made deliberately. Be it remembered that he was not a New Englander, that he was nearly sixty years of age when the institute was founded, and that until then he had spent the greater part of his active life in the southern states. To the serenity of outlook on human affairs that marks the scientist and the philosopher, he added an element of passion (perhaps derived from his Irish ancestors), when he touched the realm of education. Nowhere in the world is the supreme worth of children more thoroughly appreciated than in America; nowhere is the preparation for their future regarded more generally as one of the holy offices; nowhere in America is this sacred duty more clearly recognized and more anxiously discussed than in Boston. So Rogers placed the institute here, not because of the paucity of schools in this neighborhood, but because of their abundance; not because of their weakness, but because of their strength. This, he thought, should be good ground in which to sow fresh educational seed, and ere long his expectations were fully justified. Men of light and leading in the community gave hearty support to the new venture. Governor Banks favored state aid to the institute on the ground that such an institution would "keep the name of the commonwealth forever green in the memory of her children." His successor, Governor Andrew, who signed the institute's charter, was greatly interested, and did all that he could to help. "We ought," he said, "to start out on a broad gauge and inaugurate a great plan looking to the long future of the commonwealth." An imposing array of individuals and of societies petitioned the legislature to aid in forwarding the new scheme. Had Rogers chosen his location less wisely, he might easily have failed to enlist such support. The advantages of his chosen ground became still more apparent at the critical time when men had to be found to carry out the new ideas. He realized that this was the point where he was to gain victory or suffer defeat, and in spite of the exceptional difficulties presented, he soon succeeded in surrounding himself with the right men. The original faculty of ten professors formed a vigorous group, with great reserve of strength, physical as well as mental. They all lived to a ripe old age, and nearly all earned distinction in their own fields. Four of the men are still happily with us, including the professor of analytical chemistry, Charles W. Eliot, whose vigor is not perceptibly diminished after forty years of exacting toil in the presidency of Harvard.

It seems clear, then, that one important factor in the institute's success has been the place of its birth. And if the place was propitious, the time was in some respects peculiarly so. It was a period of upheaval, to be followed immediately by one of rapid forward movement. The charter was granted within a few days of

the breaking out of hostilities marking the beginning of the great war. The national crisis, of course, turned men's thoughts away from science and from education. About a fortnight after the granting of the charter, Rogers attended a meeting of the Thursday Evening Club, and was called upon to speak on some matter pertaining to science. According to a newspaper report of the time "Professor Rogers very gracefully declined to discuss the topic proposed, but made instead a stirring appeal to the club in favor of providing a regiment of our brave volunteers with knapsacks." Such a time seemed peculiarly unpropitious for initiating a new educational movement, and no doubt the war checked the early growth of the institute very seriously. However, after a few years, the nation was ready to turn with undivided mind to the great problems of development, and the seed having been sown earlier in good ground, the institute sprang up rapidly and reaped the harvest of hope engendered by the settlement of the grave moral and political questions to which the war was due. In the quieter field of human activity, the field of thought, the world was experiencing an equally great upheaval. Darwin's great book had just been published, with results of the first magnitude in shaping the lives on which the world of intellect was to move forward for the next half century. Kirchhoff's idea of spectrum analysis was just opening a new era in physics and in astronomy. Faraday was nearing the end of his great career, but his splendid discoveries had not yet borne fruit in the field of practise. His work, however, was having its influence on the mind of Maxwell, the greatest of whose scientific achievements was announced in 1865, the year in which the institute actually began to work. The world was just entering on a period of remarkable activity in the practical applications of science. The scientists were still struggling with the difficulties of cabling. The Boston of those days was somewhat proud of its critical spirit and in 1859 a writer in the Boston *Courier* proved at great length that all the so-called messages through the Atlantic cables were fictitious, mere shams to save the stock for a time. Edison, who was living in Boston in 1868, and whose son is an under-graduate at this institute to-day, was just beginning his wonderful career as an inventor. A few years later, one of the greatest marvels of scientific achievement, the electric transmission of speech, was to be demonstrated in this very city, indeed, in this very hall, by Alexander Graham Bell, through his invention of the telephone.

At such a time, and in such a place, an institution devoted to science and its applications had at least an excellent chance of success. The institute would, however, never have achieved what it has, if other forces had not contributed to its success. Some of these have been mentioned earlier; but there is one of the very first importance, rarely, I think, appreciated at its real value, to which special reference should be made. *There has never been any uncertainty or indefiniteness as to what the institute is aiming at in its scheme of education.* Every serious student of education is struck by the fact that so many schools and colleges drift around, apparently without compass or rudder, with no definite idea as to what port they are trying to reach, or how they should go to reach it. Here, at any rate, is an institution that, *from the very outset,* has had very definite ideas on these matters, whether those ideas be right or wrong. Most of these ideas are set forth in Rogers's "Object and Plan," which forms a charter of the institute not less valuable than that which Governor Andrew signed. At the time of writing it, Rogers was no novice in education. He

was not far short of sixty, and had taught and thought on educational problems since very early manhood. He had discussed some such project as that of the institute for twenty years at least, and his ideas thereon had gradually clarified and crystallized, as can be seen from the record of their development which is accessible to all.

Rogers has sometimes been charged with setting up a school in a spirit of antagonism to existing institutions. There is no ground for such a charge. He was too catholic in his tastes to fail to appreciate the good in others, and in advocating something new, he took the safe ground that there was room for difference in the field of education. He knew, as every educated man must know, that the fear of what is called *useful* knowledge, is exaggerated, and for the most part groundless. He knew, as others do to-day, that the oldest universities all began with a clear recognition of the bearing of their studies on definite callings; and he recognized clearly that it was not a merit but a defect of these schools that most of them had failed to keep pace with the changes in the character of human occupations that time had brought forth. He saw, as Lowell did, that "new times demand new manners and new men" and that new conditions demand new schools. For the guidance of the new school, he laid down a few simple, but far-reaching, principles, which have governed the institute ever since. The first of these is the *importance of being useful.* There is, of course, no necessary antithesis between the individual and the social end in education. However, the laying of the emphasis *is* important, and Rogers laid it unhesitatingly on efficiency in the service of society. In his first address to the students at this institute, he set forth the *value* and the *dignity* of the *practical* professions for which they were to prepare themselves. (Rogers, himself, be it remembered, was a pure scientist, President of the National Academy of Sciences, the friend of Darwin, Kelvin, Helmholtz, and the like.) In earlier discussions with his brother with reference to the plan of the institute, emphasis had been laid on "the value of science in its great modern applications to the practical arts of life, to human comfort, and health, and to social wealth and power." And so when the institute was actually founded the importance of science was kept steadily in view. He regarded the scientific habit of thought as specially valuable in practical affairs and consequently in education he laid greater stress on broad principles and their derivation than on details of fact, and he held that the *spirit* of science was more to be desired than all the gold of scientific knowledge. These are his words: "In the features of the plan here sketched, it will be apparent that the education that we seek to provide, although eminently practical in its aims, has no affinity with that instruction in mere empirical routine which has sometimes been vaunted as the proper education for those who are to engage in industries. We believe, on the contrary, that the most truly practical education, even in an industrial point of view, is one founded on a thorough knowledge of scientific laws and principles, and one which unites with habits of close observation and exact reasoning, a *large general cultivation.* We believe that the highest grade of scientific culture would not be too high as a preparation for the labors of the manufacturer." It will be seen from this that Rogers made no fetish of science, and that he welcomed every really liberal study. Some of the champions of the new school joined in the attack on the older learning; but Rogers had no sympathy with such views. "The recent discussions here and elsewhere," he said, "on the relative value of scientific and classical cul-

ture seem to threaten an antagonism which has no proper foundation in experience or philosophy." And although the study of the classics has never formed part of the institute's courses, history, economics, languages and literature enter into its curricula far more extensively than is generally supposed.

Apart from his appreciation of the value of all sound learning, Rogers saw clearly that the whole controversy as to the relative merits of science and the classics in the field of education missed the mark by placing the emphasis in the wrong place. He understood that when one gets to the root of things in education, the *method* rather than the *subject* is of supreme importance, and his insistence on the value of method in teaching was the cardinal doctrine in his creed and the one that has contributed most to the success of the institute. Doubtless his knowledge of the history of science turned his thoughts in this direction. He must have pondered over the question, as every serious student has done, why throughout the ages the world stood so still in the realm of science. It was not for lack of intellectual power, for no one who has examined the matter can fail to recognize that there really were giants of old. The failure came through attacking the problems by the wrong method. And Rogers concluded that much of the failure in education was due to similar causes. What method, then, is the right one? His fundamental idea here was not original with Rogers. It has been clearly expressed before, but rarely, if ever, adopted definitely as the basis of educational method and applied systematically throughout. The idea is familiar to us all to-day, the idea of *learning by doing*. "How can a man learn to know himself?" asked Goethe. "Never by thinking, but by doing." Add to this the doctrine of Carlyle that "the end of man is an action and not a thought, though it were the noblest," and you have the whole thing in a nutshell. Carlyle is often quoted as having said that the modern university is a great library. He would have been truer to his own doctrine if he had said that the modern university is a great laboratory. "The institute," General Walker was fond of saying, "is a place not for boys to play but for men to work." Boys and men alike learn most effectively by working for themselves, and the *do-it-yourself* method has been, I believe, the greatest factor in the success of this institute of technology.

Whatever be the explanation, there can be no doubt about the fact of its success. It is not merely that the institute is now the largest institution of its kind in this country, and as regards the extent and variety of its courses and equipment, the most nearly complete in the world. It is not merely that it has grown so that there are a hundred students to-day for every one that took the preliminary course scarcely fifty years ago, and that amongst these students there are men drawn by its reputation from the greatest universities of England, France and Germany, as well as from the leading schools and colleges throughout this union. It is not merely that its teaching staff has expanded so that it contains to-day more than two hundred and fifty men, and that amongst its hundred professors are to be found many men of prominence, and not a few of national and indeed international reputation. It is not merely that amongst its graduates, there are men of the front rank as pioneers of knowledge in the field of pure science, nor that its ten thousand alumni have played so great a part in the development of the nation's industry and commerce, and in the preservation of the public health. The most striking fact, when one

considers the institute's youth, is the fact emphasized on an earlier anniversary by Mr. Augustus Lowell and expressed by him in the phrase, "The M. I. T. is *pre-eminently a leader in education.*" Its educational ideals and methods have been studied and almost everywhere the trend to-day is in the direction in which the institute has long been moving.

To celebrate the fiftieth anniversary of the granting of the institute's charter a congress of technology has been arranged. At this congress, which opens to-day, and will be in full activity to-morrow, prominent alumni and members of the faculty are to deal with problems raised in the field of their own specialty. The guiding idea throughout is the gain in efficiency that comes from the application of scientific methods to the treatment of the great practical problems of the day. The business world must be weary of amateur suggestions for the conduct of its affairs and there is danger of damage to a great cause by too much talk. The problem of increased efficiency is no new problem to the man of affairs, and there is much that is thrust upon him in these days that he must have known for years. On the other hand, a sane and serious discussion by men who know their subject and speak from experience must always be welcome, and doubtless in the proceedings of this congress there will be much of interest to the business men who are alive to the necessity of advancement and who are on the alert for suggestions that may be helpful in their own affairs.

A glance at the program will give some idea of the variety of the interests represented, but more thorough study is needed to realize in any adequate measure that the work of this institute touches practical life at a thousand points. What the institute has achieved in half a century has fully justified Rogers's statements when making his first appeal for public support. "I am sure," he said, "that I speak from no impulse of mere enthusiasm when I say that this new undertaking presents an opportunity of practical beneficence in connection with education which is not only peculiar, but without precedent in this country. My experience as a teacher and my reflections on the needs and means of industrial instruction assure me that this enterprise, when fully understood, must command the liberal sympathy of those who aim to make their generosity fruitful in substantial and enduring public good."

R. C. Maclaurin

HENRY PICKERING BOWDITCH

Dr. Bowditch was one of the foremost leaders in the scientific development of America. In the establishment of university laboratories for research he was a pioneer and for forty years he exerted a wide and profound influence upon the progress of physiology, of medical science and of university education. It was the man himself which counted, for upon every one his sincerity, his absolute single-mindedness, his intellectual power and his genial spirit made a lasting impression, and created confidence in himself.

Bowditch was born April 4, 1840, at Boston. He descended from the best New England stock. Nathaniel Bowditch, the mathematician, well known to all navigators, was his grandfather. His father was a successful business man, who bought a large estate at Jamaica Plain, upon a beautiful hill, which has a commanding view both of Boston and of the country for many miles around. This hill is intimately associated with Dr. Bowditch in the thought of all who knew him, for he continued as one of a large family colony to dwell on it until his death.

He entered Harvard College, graduated in 1861, and entered the Lawrence Scientific School, but in November of that year he volunteered and became a second lieutenant in

the First Massachusetts Cavalry. His regiment went south in January, 1862, and from that time until the close of the civil war he was almost continually in active service. He resigned June 3, 1865, being then major of the Fifth Massachusetts Cavalry. He reentered the scientific school, and passed from there to the Harvard Medical School, from which he received the degree of M.D. in 1868. He frequently referred with gratitude to the influence of Jeffries Wyman upon his own scientific development.

With the approval and encouragement of his father he decided to devote himself to a scientific career, and as it was impossible to obtain satisfactory training in medical science at that time in this country, he went to Europe to study in Paris, Bonn and Leipzig. At the latter place he worked under Carl Ludwig, of whom he always spoke with reverence and affection. The great master found an apt pupil in the young American, and the pupil rapidly became a master himself. Bowditch had remarkable mechanical talents. Ludwig was wont to tell how Bowditch arrived in the laboratory when the kymographion invented by Ludwig was beginning to be used, and the automatic record showed only the movement of the muscle or heart, the time of stimulation being marked by hand. Bowditch immediately set to work and produced the devices for recording the actual time and the duration of the stimulus automatically. Many valuable ideas are simple, like Bowditch's invention, and after they have been produced appear obvious and invaluable, but in reality lucid simplicity is one of the essential characteristics of a superior intellect. Bowditch was endowed with this quality in a high degree, and it showed itself throughout his life in the perfection with which he worked out the problems he had to deal with. In Ludwig's laboratory he carried through his researches on the heart, which were of fundamental importance and therefore rank among the cherished classics of physiology.

He remained abroad until 1871, returning to Boston in September of that year to become assistant professor of physiology at the Harvard Medical School. Up to 1871 Dr. Oliver Wendell Holmes had lectured on anatomy and physiology, thereafter the professorship was divided. Holmes restricted himself to anatomy. Physiology was assigned to Bowditch. In 1876 he was made full professor. In 1906 he resigned his position owing to failing health, and was made professor emeritus. He met the increasing limitations of his illness with perfect courage. Courage was one factor of his power over others. Death came quietly on March thirteenth last.

The Harvard Physiological Laboratory was the first modern laboratory for instruction and research in the medical sciences to be founded in America. It was wonderfully equipped for the period of its foundation, for Bowditch put into the laboratory the large supply of apparatus, his personal property, which he had brought back from Europe. He at once began a course of lectures in physiology, which excelled so enormously anything which had ever been presented in America, that the effect was instantaneous. The consequences were revolutionary, for his work at Harvard initiated the creation of the new medical standards. The present writer was his first research pupil and recalls vividly the revelation opened by admission to the new laboratory.

During thirty-five years Bowditch was an efficient leader in the development of the Harvard Medical School, in the advancement of physiology and other medical sciences in the United States, and he found time besides to promote energetically many causes of civic betterment. Very few men have contributed so much as he to the elevation of medical education. He stood for the highest ideals of progress and maintained always that the old-fashioned "practical" physicians must be replaced by men scientifically trained and animated by the scientific spirit. For this principle he carried on a long campaign. In the face of opposition and much early discouragement he kept steadily at this great task, and had the satisfaction in the end of seeing his cause triumphant. The superiority of the laboratories abroad, especially in Germany a generation since, made a profound impression

on American students. Bowditch was one of a group of young physicians who strove successfully to found at Harvard laboratories modelled on those of Germany. The result of their efforts was the medical school building on Boylston Street, which, when it was dedicated in 1883 was easily the best for its purposes in America. From the time of the opening of this building until 1893 Bowditch acted as dean of the medical school, and during this period the school improved with unparalleled rapidity largely owing to his personal influence. He was a man who had visions of better conditions, and worked to make them realities. It was his vision which first conceived a second new medical school on a magnificent scale of equipment, and it was mainly by his persuasion that the Harvard authorities agreed to attempt to carry out the plan. He threw himself with characteristic ardor into the work. Together with Dr. John Collins Warren and others he labored, and the magnificent laboratories, opened in 1906, which the school now possesses, commemorate his devotion and success. With the completion of the cluster of five hospitals at present under actual construction or soon to be begun, which will surround the laboratories, Bowditch's dream will be fulfilled. Fortunately he lived to know that this fulfilment was assured, though he could not see it completed.

Outside causes, sometimes professional, sometimes civic, often appealed to him. Thus he was one of the principal founders of the American Physiological Society, to the affairs of which, as of the National Academy and other scientific associations, including the International Physiological Triennial Congresses, he gave of his time generously and always helpfully. With a small group of colleagues in Boston he took up psychical research, and aided in founding and for several years in managing the American society. His open-mindedness was shown in this matter and was characteristic, but his experience finally rendered him extremely skeptical as to the reality of telepathy and other alleged psychical phenomena. He was a trustee of the Elizabeth Thompson Science Fund from its foundation in 1886 until 1906. Much of the credit of the success of that fund belongs to him. In Boston he served several years on the school committee, and also as a trustee of the Public Library. Whatever he undertook he tried to do well and with such complete singleness of purpose that every one with whom he was thrown in contact instinctively trusted him.

The manifold activities, which have been referred to, encroached upon his time, and in later years he occasionally asked a friend whether his life would not have been of greater service, if he had devoted himself exclusively to experimental physiology. His success in more extended research would have been great, for in all his actual researches he was eminently successful. Thus, his work on the growth of children remains still the best on the subject. His investigations on the indefatigability of nerves, on the knee-jerk, on ciliary motion and other subjects are important and are also models both of thoroughness of experimentation and of clearness of presentation. Nevertheless, one must reply to Bowditch's own question that his life was well and wisely spent, as measured by the value of his services to the general welfare. In view of his great efficiency in promoting not only physiology but science in general and in elevating medical teaching, we must admire with grateful appreciation his career, which has been a powerful factor in the advance of research and education in America.

His own researches only partially indicate his range and efficiency as an investigator, to measure which fully one must know the work of William James, Stanley Hall, Southard, Lombard, Porter, Cannon and many others, who worked in his laboratory.

He received many tokens, both personal and official, of the high esteem in which he was held. He was an honorary member of numerous scientific bodies, and received honorary degrees from Edinburgh, Cambridge (England), Toronto, the University of Pennsylvania and his own Harvard.

Dr. Bowditch married Miss Knauth in 1871. She was the daughter of a Leipzig banker,

whose house was the center of delightful hospitality to many Americans, studying at Leipzig. He found great happiness in his home life, in his children and grandchildren, and also in the numerous friends, whom he attached not only by his unusual abilities but by his personal charm. He was social by nature, keenly humorous, warm and faithful in his attachments, full of the zest of life. He was profoundly modest and seemed never to know how high his abilites were estimated by others. He never quarrelled, but was for every good cause he championed a good fighter. Perhaps his most distinguishing trait was his remarkable combination of keen practical sense in the use of means with enthusiasm in the pursuit of ideal aims. With all his buoyant vitality, with all his eager interest in men and affairs, he was essentially an idealist, who won the love and admiration of many friends both in Europe and America.

C. S. MINOT

SAMUEL FRANKLIN EMMONS

THE death of Samuel Franklin Emmons at his home in Washington, D. C., on March 28, 1911, after an illness lasting only five days, removed from the ranks of American economic geologists the one who, by virtue of his influence on the progress of his branch of science and by his long and illustrious service, worthily stood at their head. For the last few years Mr. Emmons's increasing infirmity had given concern to his friends, but his own cheerfulness and serenity were unaffected by bodily weakness and when his colleagues missed him from his desk at the Geological Survey offices during the few days before his death they believed merely that a cold in conjunction with unseasonable weather confined him to his house. None foreboded the fatal ending of his illness.

Born on March 29, 1841, in Boston, Mass., the home of his ancestors since 1640, Mr. Emmons at his death lacked one day of his seventieth year. His great-grandfather, Samuel Franklin, after whom he was named, was a first cousin and close friend of Benjamin Franklin.

Mr. Emmons graduated from Harvard College in 1861 and went abroad to continue his studies, first at the École Impériale des Mines in Paris and afterwards at the Bergakademie in Freiberg, Saxony. He returned to the United States in 1866 and after spending eight months in visiting the mining districts of the west he joined Clarence King as a volunteer assistant in the United States Geological Exploration of the fortieth parallel, receiving his official appointment in the winter of 1867–8. For nearly ten years he remained with this organization, seeing varied service, gaining that wide knowledge of the geology of the west that he afterwards turned to such good use, and contributing to the published results of the exploration. With Mr. Arnold Hague he was joint author of the second volume of the great fortieth parallel series, entitled "Descriptive Geology" and he had a part also in the preparation of Volume III., "Mining Industry." His work carried him to Virginia City in the winter of 1867–8; to Mono Lake in March, 1868; to the unknown mountain ranges of central and eastern Nevada and of western Utah in the following summer; to the Wasatch Range and to the region adjacent to Great Salt Lake in 1869; to Mount Rainier in 1870, and to the Uinta Mountains in 1871 and 1872.

Having accomplished his duties in connection with the fortieth parallel survey, Mr. Emmons, in the autumn of 1877, returned to the west and engaged in the then stirring business of raising cattle, near Cheyenne, Wyoming. When, however, Clarence King in 1879 organized the United States Geological Survey and became its first director, he sought out his friend and associate of earlier years and placed Mr. Emmons in charge of the economic geology of the Rocky Mountain division with instructions to make a detailed survey of the newly opened Leadville district. During the field-work at Leadville, which lasted until 1881, Mr. Emmons collected the statistics of the precious metals in the Rocky Mountains for the Tenth Census and in Volume XIII. ("Precious Metals") of that publication, jointly with Dr. George F. Becker,

introduced the plan of presenting outlines of the geological relations of the ore bodies in connection with the statistical data.

The monograph and atlas on the "Geology and Mining Industry of Leadville" were published in 1888, although an abstract of results had appeared as early as 1882. This great work established the reputation of its author, not only with men of science, who recognized the care and thoroughness of the basal observations, the essential soundness of the deductions and generalizations, the breadth of view displayed, and the masterly treatment and presentation of the material, but also with the miners, who found that they could sink shafts with the certainty of finding contacts and faults substantially as Emmons had drawn them in his remarkably accurate sections. The passing years, while they have necessitated some modifications of the theoretical conclusions advanced in this monograph, have brought out more and more clearly the sound basis of honest ability and conscientious workmanship upon which lasting fame must rest. The Leadville report was preceded in publication by Becker's monograph on the "Geology of the Comstock Lode and Washoe District" and by Curtis's less extensive report on the "Silver-lead Deposits of Eureka, Nevada," but with these, and probably more decisively than these, it marked the beginning of a new era in economic geology and became the model for the numerous monographic reports on western mining districts that have since been published by the United States Geological Survey.

Up to a few years ago Mr. Emmons continued in general charge of the investigations on western ore deposits carried on by the U. S. Geological Survey and many studies were planned and completed under his supervision and with his suggestive advice. In some reports he appeared as collaborator—notably in those on the "Economic Geology of the Mercur Mining District" (U. S. Geol. Survey Ann. Rept., 1895); "Economic Resources of the Northern Black Hills" (Professional Paper No. 26), and the "Economic Geology of the Bingham Mining District, Utah" (Professional Paper No. 38); in others his share was less patent, although perhaps scarcely less important. In the series of folios of the Geologic Atlas of the United States he wrote part of No. 9, "Anthracite-crested Butte, Colo.," parts of No. 38, "Butte Special, Mont.," and No. 65, "Tintic Special, Utah," and the whole of No. 48, "Ten-mile Special, Colo." During this period of administrative and directive work he collaborated also as senior author in the monograph (No. 27) on the "Geology of the Denver Basin, Colo." (1896) and published a paper on the "Mines of Custer County, Colo." (1896).

Among the many important contributions made by Mr. Emmons to scientific journals and to the proceedings of societies may be mentioned "The Genesis of Certain Ore Deposits" (1887); "Notes on the Geology of Butte" (1887); "Structural Relations of Ore Deposits" (1888); "On the Origin of Fissure Veins" (1888); "Orographic Movements in the Rocky Mountains" (1890); "Geological Distribution of the Useful Metals in the United States" (1894); "The Secondary Enrichment of Ore Deposits" (1901); "Theories of Ore Deposition Historically Considered" (presidential address, Geological Society of America, 1904); "Los Pilares Mine, Nacozari, Mexico" (1906), and "Biographical Memoir of Clarence King" (read before the National Academy of Sciences in 1903, published in 1907).

The paper on the secondary enrichment of ores was the outcome of observations and study extending over many years and it is characteristic of Mr. Emmons's largeness of mind that he discussed this principle freely with his assistants and showed no haste to secure to himself priority in announcing results whose great scientific and practical importance he fully realized.

At the fifth session of the International Geological Congress, held in Washington in 1891, Mr. Emmons served as general secretary and was the author of a large part of the geological guide prepared for the excursion by members of this congress to the Rocky Mountains. He was also vice-president at

the sessions of the congress held in 1897 and 1903.

Mr. Emmons became a fellow of the Geological Society of London in 1874 and joined in 1877 the American Institute of Mining Engineers, of which organization he was thrice vice-president. While engaged in his early work in Colorado, with headquarters at Denver, he helped in 1882 to organize the Colorado Scientific Society, was elected its first president, and contributed extensively to its proceedings. He also took part in the founding of the Geological Society of America, of which he was chosen president in 1903. In 1892 he was made a member of the National Academy of Sciences and he filled the office of treasurer of that body from 1902 to the time of his death. He was a charter member of the Mining and Metallurgical Society of America and held active or honorary membership in many other scientific societies in this country and abroad. In 1909 both Harvard and Columbia universities conferred upon him the honorary degree of Sc.D.

During the later years of his life Mr. Emmons, freed from the cares of official administration, returned to his studies at Leadville and, in association with Professor John D. Irving, of Yale University, was engaged in extending his earlier results in the light of the additional facts brought out by extensive mining operations continued through two decades. Although some of this newer material was published in 1907 as Geological Survey Bulletin No. 320 on "The Downtown District of Leadville, Colo.," Mr. Emmons did not live to see the publication of his final results which will, however, before long be issued by the Geological Survey.

He was one of the founders, in 1905, of the journal *Economic Geology* and continued his able and enthusiastic cooperation in its behalf up to the time of his death.

Tall in person, with a figure suggestive of activity and endurance rather than of robust strength, naturally dignified in bearing and distinctive of face, Mr. Emmons, notwithstanding his genuine modesty, was a man to attract notice in any assembly. One element of his forceful character was a peculiar shyness recognizable by his friends in a certain constraint of manner and bluntness of speech likely to be misunderstood by those who were unaware of his real kindness of heart and of his genial outlook on life. A steadfast and devoted friend, he appeared to be incapable of cherishing resentment and his mind rose high above those petty considerations of priority and credit that too often vex and humiliate the souls of scientific men in spite of their better natures.

The chief characteristics of his work were thorough painstaking honesty of method, wide and penetrating vision in the interpretation of his facts, remarkable soundness and stability of judgment, and clarity of exposition. Himself able to express his thought in unusually clear and felicitous language, Mr. Emmons was an invaluable critic, not only of substance but of form, and those geologists who in their younger days were so fortunate as to receive his kindly yet keen criticism, have found their appreciation of what he did for them grow more and more with the passing years and will ever hold him in grateful remembrance. His own writings are an eloquent protest against the view that sound science can find appropriate expression in slovenly writing.

Mr. Emmons was three times married—in 1876 to Weltha Anita Steeves, of New York; in 1889 to Sophie Dallas Markoe, of Washington, and in 1903 to Suzanne Earle Ogden-Jones, of Dinard, France, who survives him. He left no children.

In the course of his long life Mr. Emmons had seen the far west that he knew and loved so well make astonishing progress, especially in the mining industry, and he had the satisfaction of knowing that by his work he had materially advanced this development. He had received unsought and bore modestly the honors that men of science most prize. His name not only stood high on the rolls of science, but was known to miners throughout the Rocky Mountain region as that of the man who more than any one else had applied geological knowledge in a way to convince them

of its value. Increasing physical disability neither embittered his cheerful spirit nor diminished his interest in science or in the general affairs of life. When he withdrew from activities in which he would once have joined it was with the unobtrusive thoughtfulness for others that foresaw some possible hindrance that his presence might occasion. His scientific associates have lost his genial sympathy, his ever ready help in worthy effort, and his ripe judgment in decisions of moment; but the inspiration of his life and character remain and probably each of those who loved him has had the heartfelt wish that when his own turn came death might summon him with like gentleness, after a life of usefulness and honor.

F. L. RANSOME

THE CONGRESS OF TECHNOLOGY

THE fiftieth anniversary of the Massachusetts Institute of Technology was celebrated on April 10, 1911. On the afternoon of April 10 President Maclaurin read the address given above. It was followed by an address by Professor W. H. Walker on the spirit of alchemy in modern industry, and by one on technology and the public health by Professor C.-E. A. Winslow. On Tuesday an elaborate program of special papers was given as follows:

SECTION A—SCIENTIFIC INVESTIGATION AND CONTROL OF INDUSTRIAL PROCESSES

Chairman, Professor W. H. Walker

"The Conservation of our Metal Resources," Albert E. Green, '07, electro-metallurgical engineer, American Electric Smelting and Engineering Co., Chicago.

"Some Causes of Failures in Metals," Henry Fay, professor of analytical chemistry, Massachusetts Institute of Technology, Boston.

"Metallography and its Industrial Importance," Albert Sauveur, '89, professor of metallurgy, Harvard University, Cambridge, Mass.

"Thirty Years' Work in Boiler Testing," George H. Barrus, '74, expert and consulting steam engineer, Boston.

"Coal Combustion Recorders," A. H. Gill, '84, professor of technical analysis, Massachusetts Institute of Technology, Boston.

"An Electric Furnace for Zinc Smelting," Francis A. J. FitzGerald, '95, consulting chemical engineer, Niagara Falls, N. Y.

"Improvements in Cotton Bleaching," Walter S. Williams, '95, textile expert, Arthur D. Little, Inc., Boston.

"The Work of Engineers in the Gas Industry," Frederick P. Royce, '90, vice-president, Stone & Webster Management Association, Boston.

"The Chemist in the Service of the Railroad," H. E. Smith, '87, chemist and engineer of tests, The Lake Shore & Michigan Southern Railway Co., Collinwood, Ohio.

"The Control of Thermal Operations and the Bureau of Standards," George K. Burgess, '96, associate physicist, Bureau of Standards, Washington, D. C.

"The Debt of the Manufacturer to the Chemist," Hervey J. Skinner, '99, vice-president, Arthur D. Little, Inc., Boston.

"Prevention and Control of Fires through Scientific Methods," Edward V. French, '89, vice-president and engineer, Arkwright Mutual Fire Insurance Co., Boston.

"Research as a Financial Asset," Willis R. Whitney, '90, director, Research Laboratory, General Electric Co., Schenectady, N. Y.

"The Utilization of the Wastes of a Blast Furnace," Edward M. Hagar, '93, president, Universal Portland Cement Co., Chicago.

"Development in Paint and Varnish Manufacture," E. C. Holton, '88, general chemist, The Sherwin-Williams Co., Cleveland, Ohio.

"Reclamation of the Arid West," Frederick H. Newell, '85, director, U. S. Reclamation Service, Washington, D. C.

"Some Problems of High Masonry Dams," John R. Freeman, '76, consulting engineer, Providence, R. I.

"Some New Chemical Products of Commercial Importance," Salmon W. Wilder, '91, president, Merrimac Chemical Co., Boston.

SECTION B—TECHNOLOGICAL EDUCATION IN ITS RELATIONS TO INDUSTRIAL DEVELOPMENT

Chairman, Dr. Arthur A. Noyes

"The Elevation of Applied Science to an Equal Rank with the So-called Learned Professions," Mrs. Ellen H. Richards, '73, instructor in sanitary chemistry, Massachusetts Institute of Technology, Boston.

"The Engineering School Graduate; His Strength and His Weakness," H. P. Talbot, '85,

professor of inorganic and analytical chemistry, Massachusetts Institute of Technology, Boston.

"Development of Mining Schools," Robert H. Richards, '68, professor of mining engineering and metallurgy, Massachusetts Institute of Technology, Boston.

"The New Profession of Economic Engineering," Roger W. Babson, '98, president, Babson's Statistical Organization, Wellesley Hills, Mass.

"Instruction in Finance, Accounting and Business Administration in Schools of Technology," Harvey S. Chase, '83, certified public accountant, Boston.

"Technical Education and the Contracting Engineer," Sumner B. Ely, '92, vice-president, Chester B. Albree Iron Works Co., Allegheny, Pa.

"The General Educational Value of the Study of Applied Science," Alan A. Claflin, '94, president, Avery Chemical Co., Boston.

"The Influence of the Institute upon the Development of Modern Education," James P. Munroe, '82, president, National Society for the Promotion of Industrial Education, Boston.

"The Training of Industrial Foremen," Charles F. Park, '92, associate professor of mechanical engineering, Massachusetts Institute of Technology; director of Lowell Institute School for Industrial Foremen, Boston.

"The Responsibility of Manufacturers for the Training of Skilled Mechanics and Shop-foremen," Arthur L. Williston, '89, principal, Wentworth Institute, Boston.

"The Function of Technical School Laboratories," H. W. Hayward, '96, assistant professor of applied mechanics, Massachusetts Institute of Technology, Boston.

"Technical Education—Its Function in Training for the Textile Industry," Charles H. Eames, '97, principal, Lowell Textile School, Lowell, Mass.

"The Contribution of the Institute of Technology toward Negro Scientific Thought," Robert R. Taylor, '92, director of industrial training, Tuskegee Institute, Tuskegee, Ala.

SECTION C—ADMINISTRATION AND MANAGEMENT

Chairman, Dr. Davis R. Dewey

"An Object Lesson in Efficiency," Wilfred Lewis, '75, president, The Tabor Mfg. Co., Philadelphia, Pa.

"The Scientific Thought as applied to Railroad Problems," Benjamin S. Hinckley, '99, engineer of tests, N. Y., N. H. & H. R. R. Co., Boston.

"Reliability of Materials," Walter C. Fish, '87, manager, Lynn Works, General Electric Co., Lynn, Mass.

"A Consideration of Certain Limitations of Scientific Efficiency," Henry G. Bradlee, '91, Stone & Webster, Boston.

"Scientific Industrial Operation," Tracy Lyon, '85, assistant to first vice-president, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

"The Trend of Commercial Development Viewed from the Financial Standpoint," Charles Hayden, '90, banker, Boston.

"Profitable Ethics," David Van Alstyne, '86, vice-president, Allis-Chalmers Co., Milwaukee, Wis.

"The Natural Increase in the Ratio of Burden to Labor in Modern Manufacturing Processes," James B. Stanwood, '75, vice-president and engineer, Houston, Stanwood & Gamble, Co., Cincinnati.

"Scientific Management of American Railways," Samuel M. Felton, '73, president, Chicago Great Western R. R., Chicago, Ill.

SECTION D—RECENT INDUSTRIAL DEVELOPMENT

Chairman, Professor D. C. Jackson

"The Elimination of some Sources of Loss in a Large Producer-gas Engine Plant," John G. Callan, '96, electrical engineer, Arthur D. Little, Inc., Boston.

"Improvements in Efficiency of Electric Lighting Properties and what the Public Gains Thereby," William H. Blood, Jr., '88, technical expert, Stone & Webster, Boston, Mass.

"Advent of Illuminating Engineering," John S. Codman, '93, electrical and illuminating engineer with the Holophane Co., Boston.

"Development of Gasoline Engines," Joseph C. Riley, '98, assistant professor of mechanical engineering, Massachusetts Institute of Technology, Boston.

"The Progress of Electric Propulsion in Great Britain," Henry M. Hobart, '89, consulting engineer, London, England.

"Mechanical Handling of Materials," Richard Devens, '88, manager eastern office, Brown Hoisting Machinery Co., New York City.

"The General Solution for Alternating Current Networks," George A. Campbell, '91, research engineer, American Telephone & Telegraph Co., New York City.

"Electro-chemistry and its Recent Industrial Development," Harry M. Goodwin, '90, professor of physics and electro-chemistry, Massachusetts Institute of Technology, Boston.

"Mail Handling Machinery at the Pennsylvania Railroad Terminal and United States Post Office

at New York City," Julian E. Woodwell, '96, consulting engineer, New York.

"The Development of a System of Underground Pneumatic Tubes for the Transportation of United States Mail," B. C. Batcheller, '86, chief engineer, American Pneumatic Service Co., New York City.

"The Continuous Cooling of Circulating Water used for Condensing Steam," Edward F. Miller, professor of steam engineering, Massachusetts Institute of Technology, Boston.

"Power Plant Betterment," H. H. Hunt, '89, Stone & Webster Management Association, Boston.

"The Development of Economical Ore Dressing Systems," Frank E. Shepard, '87, president, Denver Engineering Works, Denver, Colo.

"Recent Developments in Bridge Construction," Frank P. McKibben, professor of civil engineering, Lehigh University, South Bethlehem, Pa.

"The Manufacture and Use of Asbestos Wood," Charles L. Norton, '93, professor of heat measurements, Massachusetts Institute of Technology, Boston.

"The Technics of Iron and Steel," Theodore W. Robinson, '84, vice-president, Illinois Steel Co., Chicago, Ill.

SECTION E—PUBLIC HEALTH AND SANITATION

Chairman, Professor W. T. Sedgwick

"Profitable and Fruitless Lines of Endeavor in Public Health Work," Edwin O. Jordan, '88, professor of bacteriology, University of Chicago, Chicago, Ill.

"The Technical School Man in Public Health Work," Harry W. Clark, '88, chief chemist, State Board of Health, Boston.

"Present Status of Water Purification in the United States and the Part that the Massachusetts Institute of Technology has Played," George C. Whipple, '89, consulting engineer, New York City.

"The Pollution of Streams by Manufacturing Wastes," William S. Johnson, '89, sanitary and hydraulic engineer, Boston.

"Sewage Disposal with Respect to Offensive Odors," George W. Fuller, '90, consulting hydraulic engineer and sanitary expert, New York.

"The Food Inspection Chemist and his Work," Herman C. Lythgoe, '96, analyst, State Board of Health, Boston.

"The Life Saving Corps of the Technical School," Severance Burrage, '92, professor of sanitary science, Purdue University, Lafayette, Ind.

"Factory Sanitation and Efficiency," C.-E. A. Winslow, '98, associate professor of biology, College of City of New York, New York City.

"A Review of the Work of the Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology," Earle B. Phelps, '99, consulting sanitary expert, New York City.

"Bacteria and Decomposition," Simeon C. Keith, Jr., '93, assistant professor of biology, Massachusetts Institute of Technology, Boston.

SECTION F—ARCHITECTURE

Chairman, Professor F. W. Chandler

"Landscape Architecture, a Definition and a Brief Résumé of its Past and Present," Stephen Child, '88, landscape architect and consulting engineer, Boston and Santa Barbara.

"Some Phases of Modern Architectural Practise," Walter H. Kilham, '89, architect, Boston.

"The Engineer and Architect Unite," Luzerne S. Cowles, '97, assistant designing engineer, Boston Elevated Railway Co., Boston.

"Mill Construction with Steel Frame and Tile Walls," John O. DeWolf, '90, mill engineer, Boston.

SCIENTIFIC NOTES AND NEWS

Sir J. J. Thomson, Cavendish professor of experimental physics in the University of Cambridge, and Dr. D. Hilbert, professor of mathematics at Göttingen, have been elected corresponding members of the Paris Academy of Sciences.

The University of Edinburgh will confer its doctorate of laws on Mr. Frank W. Dyson, the astronomer royal, and on Dr. Ernest Rutherford, professor of physics in the University of Manchester.

The University of Aberdeen has conferred its LL.D. on Dr. A. R. Cushny, professor of materia medica in the University of London, on Dr. Arthur Keith, Hunterian professor of anatomy in the Royal College of Surgeons, and Major P. A. Macmahon, deputy warden of the standards.

Dean Liberty H. Bailey, of the State School of Agriculture at Cornell University, has written to Governor Dix, of New York, expressing regret that he can not accept the appointment of state commissioner of agriculture.

MR. ROBERT CUSHMAN MURPHY has been appointed curator of the division of mammals and birds in the Museum of the Brooklyn Institute of Arts and Sciences in place of George K. Cherrie, who recently resigned. Mr. Robert H. Rockwell has been appointed chief taxidermist of the same institution to fill the position left vacant by the death of Mr. Critchley.

J. W. TURRENTINE, Ph.D. (Cornell, 1908), instructor in physical and electrochemistry in Wesleyan University, has been appointed scientist in Soil Laboratory Investigation, Bureau of Soils, Washington, D. C.

MR. J. B. HILL, who joined the staff of the British Geological Survey in 1884, has just been appointed to the newly-created post of geological adviser to the local government board.

THE services which Dr. Lazarus Fletcher, F.R.S., has rendered to the Mineralogical Society during his twenty-one years' tenure of the office of general secretary have been recognized by the presentation to him of his portrait painted by Mr. Gerald Festus Kelly.

THE Tiedeman prize of the Senckenberg Natural History Society of Frankfort has been awarded to Dr. Richard Willstätter for his researches on chlorophil.

DR. R. HAMLYN-HARRIS has been appointed director of the Queensland Museum.

DR. EDMUND B. HUEY has resigned his position as clinical psychologist to the Illinois state institution for the feebleminded at Lincoln, Illinois, to continue clinical research at the Johns Hopkins Hospital and in the city of Baltimore.

PROFESSOR WM. B. ALWOOD, enological chemist, in the Bureau of Chemistry, Washington, D. C., sailed on April 13 for Gibraltar and will investigate viticultural conditions in Spain, Italy, France and Germany. He will also participate as a delegate in the International Agricultural Congress at Madrid and in the International Viticultural Congress at Montpellier. Professor Alwood is on the program for papers on the discovery of "Sucrose in American Grapes" and "On the Chemical Composition of American Grapes."

THE Laysan Island Expedition from the State University of Iowa sailed on April 5 from San Francisco on the U. S. Army Transport *Sherman*. The party consists of professor Homer R. Dill, in charge of the expedition, Mr. Charles A. Corwin, of Chicago, artist, and Messrs. Horace Young and Clarence Albright assistants. These men are to be stationed on the Island of Laysan in mid Pacific for a period of about two months, and are to furnish a detailed report to the U. S. Biological Survey, Department of Agriculture, regarding the famous bird rookeries of Laysan, with special reference to the effects of the raid made on them by Japanese feather hunters about two years ago. The island is a part of a "Bird Preserve" by proclamation of President Roosevelt, and the members of the expedition are appointed as game wardens during the period of their stay. The expedition is financed by friends of the State University of Iowa, and the party has permission to secure material for a cycloramic exhibition of the bird rookeries which is to be installed in the museum of natural history of the university.

MR. MAURITZ SAHLBERG, of Sweden, is on an extended visit to this country to study hydroelectric developments for the department of commerce of the Swedish government.

ON the evening of April 5, Professor G. W. Ritchey, astronomer of the Solar Observatory of the Carnegie Institution, delivered an illustrated lecture before the Indiana University chapter of Sigma Xi, on "Stellar Photography."

DR. ELIHU THOMPSON, of the General Electric Company, lectured on March 31 to the students of Throop Polytechnic Institute, Pasadena, Cal.

WE learn from *Nature* that it is proposed, in memory of the late Dr. Louis Olivier, founder of the *Revue générale des sciences*, to publish a book containing contributions from men of science and letters who knew M. Olivier. The volume is to appear next August for the anniversary of the death of M. Olivier,

and will be accompanied by a booklet containing his portrait, a biographical sketch and a bibliography of his works.

Ten thousand dollars has been contributed to the University of Pennsylvania to establish a memorial to the late Dr. J. A. Scott, adjunct professor of medicine in that institution. This memorial will take the form of a fellowship for medical research.

It is proposed to erect in Amsterdam a monument to the memory of the late Professor van't Hoff.

Dr. Charles A. Oliver, of Philadelphia, known for his contributions to ophthalmology, has died at the age of fifty-seven years.

Mr. Arthur Ray Maxson, instructor in mathematics at Columbia University, died on April 13, at the age of thirty years.

Dr. Jak. M. Van Bemmelen, emeritus professor of chemistry at Leyden, died on March 14 in his eighty-first year.

The paleontologist, Professor Joseph Lahusen, died in St. Petersburg, on March 8, at the age of sixty-six years.

Pieter Cornelius Tobias Snellen, the Dutch entomologist, has died at seventy-seven years of age.

The *Bulletin* of the American Mathematical Society gives the names and theses of candidates who received doctorates in mathematics from the German universities during the academic year 1909–10. They number 38, Leipzig leading with seven. About fifteen doctorates in mathematics are given annually by the universities of the United States.

The Russell Sage Institute of Pathology, which was founded in 1907 when Mrs. Sage gave $300,000 for pathological research work in connection with the hospitals and charitable institutions on Blackwell's Island, has resolved to terminate the agreement existing with the Public Charities Department.

The London *Times* states that at a meeting of the Paris Academy on April 3, Prince Albert, of Monaco, announced that he would shortly commission a new steamship, the *Hirondelle II.*, to take the place of the *Princesse Alice II.*, which had 12 scientific cruises to her credit. He informed the academy that, thanks to a new dredging apparatus, interesting specimens of the denizens of the intermediate depths of the ocean had been secured. The apparatus consisted of a net, which could be dragged at a speed of 15 kilometers an hour at any depth. In 1910 the *Princesse Alice* had towed this appliance at a depth of 5,000 meters, and a dozen new kinds of fish had been brought to the surface in as many days. Arrangements had likewise been made for taking instantaneous color photographs of the specimens as soon as they were hauled up out of the water.

According to *Nature* three expeditions from England will observe the total solar eclipse of April 28, on Varau, a small coral island of the Friendly Group. They are as follows: (1) A government expedition from the Solar Physics Observatory with Dr. W. J. S. Lockyer, in charge, and accompanied by Mr. F. K. McClean, left London on February 3, with the necessary gear, and journeyed to Sydney by the Orient steamship *Otway*. From there the instruments were transhipped to H.M.S. *Encounter*, of the Australian Squadron, and the expedition started for the Friendly Islands on March 25. (2) An expedition from the Joint Permanent Eclipse Committee will be under the charge of Father A. L. Cortie, S.J., from Stonyhurst Observatory, who will be assisted by Mr. W. McKeon, S.J., and Father E. F. Pigot, S.J. Father Cortie's expedition also travelled by the *Otway* from London, and proceeded to Varau on board the *Encounter*. (3) A private expedition in charge of Mr. J. H. Worthington, who has had a special equipment made for this eclipse.

Perhaps no other metal has been used in so great a variety of ways during so comparatively brief a history as has aluminum. It is a question whether the automobile industry would have made such a remarkable progress during the last decade without the accompanying development of the metallic aluminum industry, for very many of the castings used in the manufacture of motor cars are made from this light, rigid metal. The use of aluminum in the recently born art of aviation is also of great popular interest, and here again the same

qualities of lightness and rigidity recommend it. Aluminum is the most abundant of all the metals. It is an essential constituent of all important rocks except sandstones and limestones. It is found chiefly in the silicates such as the feldspars, micas, clays, etc.; and as the hydroxide in the mineral bauxite, from which it is now produced on a commercial scale. Its oxide makes up between 15 and 16 per cent. of the earth's crust. In spite of this great abundance the metal itself was, up to 1880, a chemical curiosity, and one of the early reports of the United States Geological Survey quotes it at $1.25 a Troy ounce—$15 a pound. The reason for its rarity and high price was the lack of a commercial method of extracting it easily and cheaply from its chemical combination with oxygen, for which it has a remarkable affinity. With the introduction of electrolytic processes the metal has now taken a high place among the commercial metals, and from a production of 83 pounds in 1883 its consumption amounted in 1909 to the enormous total of 34,210,000 pounds, valued at approximately 23 cents a pound for ingot metal.

UNIVERSITY AND EDUCATIONAL NEWS

HARVARD UNIVERSITY has received the hundred thousand dollars required for the Wolcott Gibbs Memorial Laboratory which is to form the first building of the new chemical laboratories to be erected south of the university museum. It is understood that half of the sum was given by Dr. Morris Loeb and Mr. James Loeb. It is estimated that about $65,000 will be needed for the construction of the building. The rest of the $100,000 will be used for maintenance.

AT a stated meeting of the trustees of Princeton University on April 13, gifts amounting to more than $90,000 were announced.

DR. DANIEL K. PEARSONS, the Chicago philanthropist, whose benefactions to the various colleges and benevolent institutions have exceeded $6,000,000, celebrated his ninety-first birthday on April 14 and marked the occasion by distributing $300,000, including $100,000 to Berea College, $25,000 to Deane College and $10,000 to McKendree College.

THE North Carolina legislature at its last meeting appropriated to the University of North Carolina $200,000 for equipment and increased the appropriation for maintenance to $87,000 a year. The trustees have decided to erect first a medical laboratory costing $50,000.

As has been announced in SCIENCE a bill proposing one board of control for the three educational institutions of Kansas was vetoed recently by Governor Stubbs. He had proposed to the legislature a commission form of government for the institutions, five members to take the place of the eighteen now acting as regents, but a bill was passed providing for a board of three, each to receive $2,500 a year, to give their whole time to the management of the State University at Lawrence, the State Normal School at Emporia and the State Agricultural College at Manhattan. As these institutions have within their walls approximately seven thousand students, Governor Stubbs believed that one man competent to plan the educational and business program for each of them would be worth much more than $2,500. This opinion was confirmed when he attempted to fill the positions and found out that the present incumbents, serving for no salaries, would not agree to continue their services. The leading educators of the country telegraphed to Governor Stubbs, in response to inquiries, that the one-board principle was advisable, but the methods about to be pursued by Kansas in adopting that system were faulty, particularly in the number of members proposed and the remuneration offered. The strongest opinions against the measure came from states where a similar plan is being tried or has in the past been tried. Governor Stubbs did not care to take upon himself, he said, the responsibility for disorganizing the educational system of the state and therefore he vetoed the bill.

GOVERNOR LEE CRUCE, of Oklahoma, has appointed a board of education consisting of six men, to take charge of all of the state educational and charitable institutions. This board

was ordered by the recent legislature, and succeeds the boards of regents of the university, the normal schools, the deaf and dumb school, the blind school, the girls' industrial school, the university preparatory schools, the various charitable institutions, etc.; and also succeeds the former text book commission. Governor Cruce, in his address to the members of this board, said in part: "I regard this board as the most important public body which has ever been, or ever will be constituted in this state. This is a radical departure from established methods, and it is impossible for me to overstate the interest and anxiety I feel for the successful outcome of your labors. I want to say, with all the emphasis that I can command, that politics absolutely be eliminated from educational matters in Oklahoma—as thoroughly as church and state are now divorced. Members of this board may be removed for cause, and I should regard it as good and ample cause for removal if any member should permit political or personal motives to influence him in the employment or discharge of persons connected with the state schools, or in any other matters coming within the jurisdiction of this board."

At its recent session the legislature of Kansas appropriated approximately one million dollars for the State Agricultural College at Manhattan for the next biennium. The funds provide for one wing of an agricultural building, with a detached laboratory for the cutting and curing of meats. The first wing of the new building is to cost $125,000. Two more wings are to be added as the money is appropriated, each complete in itself. The legislature also provided a special fund of $22,000 to complete the armory and gymnasium, which included literary society halls, swimming pools, and complete equipment for the whole; money for experiments in the western part of the state in cooperation with the federal government; for soil surveys, also in cooperation with the United States government, $5,000 a year; for experiments in producing improved wheat, corn and other crops, $7,500 a year. The college has this year approximately 2,500 students, more, it is said, than are enrolled in any similar institution in the world. The cost per student in this institution in 1910 was $107. Kansas, with a population of less than 1¾ millions, had, in 1910, more students in colleges than had Missouri, with more than 4 million population. Illinois, in its agricultural college and university combined, had 4,638 students in 1910. Kansas, with its agricultural college and university separate, had 4,608 students, thirty fewer than Illinois, which has 6 million population.

Mr. Andrew Carnegie has given $25,000 to the faculty of medical sciences of London for the section of a building to be devoted to pharmacology.

As has been noted here M. Loutreuil bequeathed $500,000 to the University of Paris. The bequest is on condition that the provincial universities also shall benefit by the revenue which is to be devoted to the encouragement of scientific studies, the equipment of laboratories, the formation of a library and the foundation of additional lectureships on scientific subjects.

Dr. Lajos Schlesinger, of the University of Budapesth, has been called to the chair of mathematics in Giessen as successor of Dr. Moritz Pasch.

At Princeton University Dr. H. N. Russell has been promoted to be professor of astronomy.

DISCUSSION AND CORRESPONDENCE

THE MEANING OF VITALISM

Professor Ritter's interesting address as vice-president of Section F of the American Association[1] makes manifest once more a difficulty which confronts every one who would discuss the question of vitalism: namely, the lack of either clear or generally accepted definitions of the terms ("vitalism" and "mechanism") used to designate the opposing doctrines under discussion. Professor Ritter himself is so sensible of this difficulty that he frankly gives up attempting any complete conformity to "lexicographical authority and historical usage," and simply puts forward

[1] Science, Vol. XXXIII., No. 847, March 17, 1911, pp. 437–441.

special definitions *ad hoc,* of his own formulation, as an indication of the particular doctrines with which he is for the time being concerned. This, of course, is a perfectly legitimate procedure; but even this wise precaution can free the ensuing discussion from irrelevancy and terminological confusion only upon three conditions: first, that the definition itself be unequivocal; second, that the writer subsequently use the term only in the sense defined; and third, that the sense given to it by his definition correspond to doctrines actually held by contemporary writers worth considering, and to the fundamental principles of those doctrines rather than to their adventitious details. I am not quite sure that the first two conditions are wholly fulfilled in Professor Ritter's discussion; his definition of vitalism seems to me diffuse and of rather elusive meaning, and it does not seem altogether clear that the vitalism with which some of his remarks deal is the vitalism defined. These, however, are merely questions of verbal consistency upon which it would be unprofitable to dilate. Of more material consequence is the third requirement; for if it be not fulfilled, the discussion, however clear and unambiguous, is unlikely to be pertinent to *the* controversy over vitalism, as an important contemporary issue. Do, then, Professor Ritter's definitions really expose the nerve of that issue? I am not convinced that they do. In order, however, to avoid a merely *ad hominem* argument, I should like to suggest another way of approaching the matter which seems to me more likely to expedite an ending of the controversy between mechanism and vitalism. I shall do so by indicating in the order of their logical priority what appear to be the three essential questions involved in the controversy, and the nature of the opposing views which may be, and have been, taken upon each of these questions.

1. The first question concerns the logical relation of the "laws" or generalizations of biology to those of other sciences. The mechanistic doctrine, whatever more it may imply, at least asserts that the explanations of organic processes can eventually be found in the laws of some more "fundamental" science whose generalizations are more comprehensive than those of biology, covering some (or all) inorganic phenomena, as well as organic. The full mechanistic program would be realized if biological laws could be shown to be special cases of chemical laws, these in turn of physical, and these finally of the laws of mechanics. Roux, for example, thus sets down the aspiration of the science of *Entwicklungsmechanik: Das organische Geschehen . . . auf anorganische Wirkungsweisen zurückzuführen, es in solche Wirkungsweisen zu zerlegen, zu analysieren.* The vitalist, on the other hand, however much more he may assert, maintains at least the impossibility of this reduction of organic processes to the laws of the sciences of the inorganic. The first article of the creed of the recent defenders of vitalism, and perhaps the one article on which they are all agreed, is the principle of *Lebensautonomie,* which is thus formulated by von Hartmann: *Aus anorganischer Materie kann das Organische* von selbst, d. h. nach anorganischer Gesetzlichkeit allein, *nicht entstehen.*

But what precisely is the matter at issue here, and by what test, if it were available, could the issue be decided? In what would a *Zurückführung* of biology to chemistry or physics consist? It would consist in showing that a given organic process A can be subsumed under and *deduced from* a given generalization, B, of the more "fundamental" science. The proof of the autonomy of biology, on the other hand, would consist in showing that there are modes of action characteristic of matter when organized into a living body which can never be deduced from any law that describes any modes of action of inorganic matter. But here an explanation about deducibility is needful, since the notion has been somewhat confused in some recent discussions. From *no* general law alone, even if it is known to be true, can *any* more special law, or individual phenomenon, be deduced; and this follows from the very notion of a scientific law. For such laws are generalized statements of certain constant correlations *between two or more variables;* and in order

that from the law anything more specific shall be predicted or deduced, it is necessary that there be given empirically certain information concerning at least one of the variables. Without some empirical knowledge concerning the motions or masses of some bodies, nothing could be inferred about bodies from the law of gravitation. For this additional empirical knowledge about the actual values of the variables the laws themselves, if properly formulated, expressly call. But the undeducibility of biological from other laws, which the vitalist asserts, is not simply the undeducibility due to a lack of the specific empirical information called for by those other laws. What the vitalist maintains is that, even given a complete knowledge *both* of all the laws of motion of inorganic particles and of the actual configuration of the particles composing a living body at a given cross-section of time, you could not from such knowledge deduce what the motion of the particles, and the consequent action of the living body, would be. What he asserts primarily, in short, is the doctrine of the logical discontinuity, at certain points, of scientific laws. This discontinuity does not necessarily imply any breach of the principle of causal uniformity. Whenever a number of particles acting in accordance with one set of laws (*e. g.*, of mechanics) are brought into a certain configuration, they may conceivably thereafter take to moving in ways not correctly described by the aforesaid laws; if so, the conditions under which the shift from one mode of action (*i. e.*, action of which a correct generalized description is given by the one set of laws) to the other mode takes place are uniform, and a new law may be formulated setting forth that very uniformity of discontinuity. Again, such a view would not, in itself, deny that the behavior of organisms is a function of the number and configuration of the material particles composing them.

Such a doctrine of the autonomy of a given science might conceivably be applied to other sciences besides biology. It might be held, for example, that chemistry is similarly autonomous with respect to physics, or psychology with respect to biology. It might, again, be maintained that the real point of discontinuity comes, not where chemistry connects with biology, but rather where physics connects with chemistry—biological phenomena being in themselves theoretically inferrible from chemical laws, when chemical laws are more adequately known. I do not now inquire whether any such views are plausible or not; I merely point out that vitalism is first of all a special case of what might be called scientific autonomism, or logical pluralism. Mechanism, meanwhile, asserts the possibility of an eventual unification of scientific laws. Between the two is possible an agnostic position, based upon the observation that both sides agree that no such unification is yet achieved, and that both have some difficulty in proving either that it must be or that it can not be achieved in the future.

In so much of vitalism, however, there appears to be nothing that can properly be called "mystical" or "transcendental," nor anything that can especially profitably be regarded as a survival of primitive animism.

2. There is, however, a doctrine which goes beyond this mere assertion of organic autonomy, and declares that (in part) the action of living bodies *is not strictly a function of the number and spatial configuration of the particles composing them at any given instant.* In other words, organisms not only have unique laws of their own, but these laws can not even be stated in terms of the number and arrangement of the organism's physical components. Not all who call themselves, or have been called, vitalists assert so much as this; but the neo-vitalism of Driesch maintains precisely this view, and endeavors to support it by definite empirical evidence. Driesch seeks in the phenomena of regulation, regeneration and conscious behavior, evidence for the assertion that the composition (physical and chemical) of an organism, on the one hand, and its morphogenesis and activity, on the other, are (to some extent) independent variables. With a radical variation in composition—*e. g.*, after the elimination of half the blastomeres at a certain stage of develop-

ment in certain embryos—you may, he contends, get an identical resultant form (except with respect to size). About the experimental facts there can be no question; though there appears to me to be a fairly evident flaw, of a purely logical sort, in the inference which Driesch draws from them. I do not, however, wish here to discuss the truth of vitalism, but merely to elucidate its import. But even for the latter purpose it is important to note that Driesch's vitalism by no means maintains that the specific properties or activities of organisms are not functions of *any* antecedent material or physico-chemical configuration. Whales do not develop from sea-urchin's eggs, nor does the unfertilized egg develop at all. Always you must first have given a definite mechanism, at the beginning of any morphogenetic or other vital process; and for different products you must have different original mechanisms. All that Driesch maintains is that such a process once started continues towards its normal consummation even if, after the start, some of the usual machinery instrumental to that consummation is lost and the rest has to redistribute and redifferentiate itself in order to keep things moving in the customary manner. In short, even the processes in which Driesch finds the independent variability of the physical mechanism of a living body and its physiological processes exemplified, still, even for him, have perfectly definite, perceptible and experimentally ascertainable constant antecedents, if you go back to an early enough stage in the given sequence of processes.

3. The fundamental questions concerning vitalism are the first two questions: Can some biological phenomena be shown to be, in the sense defined, autonomous? and can some of them even be shown not to be functions of any fixed configuration of material parts existing in the organism or cell at the moments at which the phenomena take place? Now, one might conceivably answer one or both of these questions in the affirmative, and stop there. Such would be the procedure of a convinced vitalist who had caught the spirit of scientific positivism. But most vitalists, undoubtedly, are not of a positivistic temper, and they have accordingly often gone on to account for the asserted peculiarity or uniqueness of organic *processes* by hypostatizing special *forces* or agents as causes of these peculiar modes of action. Such hypostases have been made in three different fashions by three recent schools of biological philosophers, of which the first would apparently refuse to be called vitalistic. The qualitative *Energetiker* (*e. g.*, Ostwald, Rignano) in so far as they set up as a real entity a specific vital or neural form of energy, having properties and modes of action not characteristic of energy in any other of its transformations, seem to imply both the autonomy of organic phenomena and the need of postulating a special dynamic background for these phenomena. The psycho-vitalists (who are indeed biological animists), such as Pauly, Francé, Strecker, find the cause of the unique modes of physical behavior distinctive of organisms in a *seelisches Innenleben*, a rudimentary form of consciousness and of purposive action, ascribed to even the simplest living things. And Driesch and Reinke and their followers, in order to explain how organisms can, as these biologists believe, pursue their typical ends even after a considerable modification or partial destruction of their usual machinery, postulate "entelechies" or "dominants" having the power, so to say, to take command even of a disabled organic ship and steer it (under certain conditions) to its destined port.

Now, it is doubtless in these vitalistic hypostases that Professor Ritter finds the trait which makes vitalism resemble savage animism. I wish, therefore, to insist upon two considerations in this connection. In the first place, as I have tried to show, the question whether it is worth while to set up such hypostases, not open to direct observation, is wholly subsidiary to questions 1 and 2, which have to do with potentially ascertainable facts concerning the *laws* of organic processes. If the verdict upon either of those questions goes in favor of the vitalist's contention, the main issue is settled. Whether, vitalism being assumed, it would be worth while to postulate

hypothetical and imperceptible forces or entities to account for the perceptible facts, is essentially a question of scientific convenience. The presumption, surely, is in favor of the positivistic method, which is content to correlate the observable data without going behind them. Yet it must be confessed that it is not by such avoidance of hypotheses concerning imperceptible causes or substances that physics and chemistry have achieved their best results. And the precedent of those sciences might be plausibly (though, I think, unwisely) made, by one convinced of the truth of the vitalistic answer to one or the other of the first two questions, an excuse for not taking his vitalism positivistically or pragmatically. In any case, these hypothetical "forces" or causes would constitute elaborations or embellishments of his doctrine; they would not constitute the basis or the irreducible minimum of it.

A word in conclusion about the position of Bergson, of which Professor Ritter speaks with cordial approval. Bergson holds the doctrine of organic autonomy in a special and a somewhat extreme form. Inorganic and organic processes manifest, in his opinion, radically dissimilar modes of causality. "The present state of an inanimate body depends exclusively upon what took place at the preceding instant. The position of the material points of a system is determined by the position of the same points at the immediately antecedent moment. In other words, the laws which control unorganized matter can be expressed in differential equations in which *time* (in the mathematician's sense) plays the part of an independent variable." This, Bergson insists, is not true of living bodies; their present state does *not* "find its complete explanation in the immediately anterior state." We must absolutely give up "the idea that the living body could be subjected by some superhuman calculator to the same mathematical treatment as that which is applied to our solar system." The "creative" efficacy of organic evolution is shown, for Bergson, precisely in the impossibility of deriving from even the most complete knowledge of the configuration of the components of an organism at a given moment, and of all the "laws" which have been disclosed up to that moment, any absolutely complete and certain knowledge of the future condition and action of that organism. Bergson, moreover, does not stop with this anti-mechanistic view of the actual behavior of organisms; he suggests an explanation for what he conceives to be the facts. And his explanation, though rather elusive, approximates that given by the psycho-vitalists. The neo-Lamarckians, he declares, are right in referring organic evolution to "a cause of the psychological order," though they apprehend this too narrowly. The conception of "effort should be taken in a sense more profound, a sense even more psychological, than any neo-Lamarckian has supposed." It is true that Bergson does not seem to call his doctrine vitalism, and that he speaks in criticism of the vitalism of certain other writers. But it seems to me that any dogmatic (*i. e.*, not merely provisional or agnostic) anti-mechanism in biology should be called vitalism. In other words, the doctrine which it appears to me to be linguistically most convenient to designate by that name is the doctrine of organic autonomy in its biological application, the assertion of an essential logical discontinuity between the "laws" or modes of action of matter dealt with by biology and the "laws" of all the sciences of the inorganic. And in this sense, of course, Bergson is an unmistakable and a radical vitalist. It would certainly be paradoxical to withhold the name from a writer who does not hesitate to say that the "parts of an organized machine do not correspond to parts of the work of organization, since *the materiality of this machine does not represent a sum of means employed, but a sum of obstacles avoided*" by the *élan vital* in its form-creating activity.

Arthur O. Lovejoy
The Johns Hopkins University

PRODUCTIVITY OF SOILS

The discussion of the "Secular Maintenance of Soils" by Professor Chamberlin

before the Geological Club of the University of Chicago aimed at so fundamental and comprehensive a presentation of the subject and the report of it by himself in Science, February 10, p. 225, is cast with such pedagogic effect that it is much to be regretted that a goodly part of the discussion was not incorporated with the report, as without this some statements are likely to be interpreted in a way widely at variance with authentic data and hence in a way to be misleading.

Although most that is said is undisputed, this presentation in fifty-three terse statements of somewhat unusual form is certain to convey to younger students of the subject the impression that each and all of these phases of the great problem of soil productivity have been brought into the clear light of science and are here set out in proper order. This is, of course, not true and not intended to be so understood but the great confidence accorded to the author's utterances is in danger of leading to the acceptance of his suggestions and beliefs as established knowledge, and to assigning to minor factors an importance far too great.

The importance of capillarity in supplying potassium and phosphorus to crops, emphasized by the figures which are cited, will be understood as being much greater than can be the case. Indeed, instead of the "capillary cycle" and the "plant cycle" tending on the whole to the concentration of potassium and phosphorus toward the surface of the soil contributing to "secular maintenance," as is implied, quite the reverse tendency is the case, as may be seen from a comparison of the composition of soils and of rocks. We cite the complete analyses of 27 soils given by Hopkins[1] in the form of mean values for three depths.

In this series 74 per cent. of the cases in the second depth have the potassium higher than in the surface soil, and 59 per cent. of the cases in the third depth have the content higher than in the surface sample. The larger amount of phosphorus compounds in the surface soil is not a case of concentration due to the action of either or both cycles named, but has occurred in spite of them and is less than it would have been because of their action. The most pronounced effect of both "cycles" is to leave soluble ingredients upon or above the surface of the soil whence they are transported to the sea by both surface drainage and wind action, the loss in this way being materially greater than the supply by capillarity to the root zone.

Depth	Phosphorus (P) lbs. per million	Potassium (K) lbs. per million
0 to 6⅔ inches	581	16,376
6⅔ to 20 inches	485	16,649
20 to 40 inches	488	16,936

	Igneous Rock	Sedimentary rock: Shale	Sand-stone	Lime-stone
	Pounds per million			
Potassium	24,400	26,981	10,959	2,740
Phosphorus	1,100	7,426	3,494	1,747

The phosphorus content[2] of all rocks is seen to be higher than that of soils, and the higher content of sediminetary rocks will not be ascribed to either capillary or plant action, but to other processes named in the article. It must of course require a positive addition of plant food elements to cultivated soils, in amounts equal to or greater than all removals, to perpetuate indefinitely uniform or increasing productivity.

Studies like those of Professor Whitson[3] of phosphorus in cultivated and virgin soils indicate, in the case cited, an average loss of P_2O_5 during about sixty years, of 1,255 pounds per acre, from the cultivated soil, and in but three of the nine comparisons was the loss less than that which would be assigned to removal by crops. It may fairly be questioned whether this difference is due entirely to greater loss from the cropped soils, but it

[1] "Soil Fertility and Permanent Agriculture," pp. 82–87.

[2] "Data of Geochemistry," Bull. No. 330, U. S. Geol. Survey, pp. 26–27.

[3] Research Bulletin No. 2, University of Wisconsin Agr. Expt. Station.

will hardly be urged that it is even chiefly due to capillary and plant concentration such as might prevail over large areas like the United States. At least the projection of such a rate of concentration through any material period forward or backward would point to very unusual if not impossible conditions.

If it be true that 1,200,000 tons of PO_4 are lost annually from the soil of the whole United States by drainage into the sea and that capillary water is carrying toward the surface 18,000,000 to 40,000,000 tons, there would be a total mean movement of 30,200,000 tons of PO_4 or 9,800,000 tons of phosphorus. A yearly removal at this rate maintained for 10,000 years would require more phosphorus than is carried in 10.5 feet of igneous rock, assuming 200 pounds as the weight of a cubic foot and Clark's value cited above; and all of the phosphorus carried in 40 feet of soil weighing 4,000,000 pounds per acre-foot, containing 581 parts per million of phosphorus. A combined chemical and mechanical erosion which would remove 40 feet in 10,000 years, from the United States, would have to exceed one inch in 21 years.

It appears to be overlooked, in making the estimates, that capillary sweeping is very often and strongly downward as well as upward, and also that a large proportion, probably more than three-fourths of the rainfall, not removed in the runoff, never penetrates the soil beyond a depth of two feet and should not, therefore, be used as a measure of surfaceward movement of plant food below that depth. We have measured the combined capillary and internal-evaporation-movement out of the 5- to 10-foot depth into the 0- to 5-foot depth in four instances, two of which were a clay loam and two a sandy loam soil. The measurement was continuous through 314 days under a summer temperature. Under the most favorable conditions for upward movement water was carried from the 5- to 10-foot zone into the 0- to 5-foot zone at the rate of three pounds per square foot during the 314 days, where the surface was continuously firm, while under a 2-inch earth mulch the movement was 2.2 pounds. In the sandy loam the movement out of the 5- to 10-foot zone into the 0- to 5-foot zone was less than .8 pounds in 314 days. The annual combined upward movement from the 5- to 10-foot zone into the 0- to 5-foot zone, at the most rapid rate, was .7 inch in the clay loam and .17 inch in the sandy loam.

Assuming a soil solution containing 20 parts per million of PO_4, the total phosphorus which might thus be added to the surface five feet from the five feet below, would be but 1 to .25 pound per acre annually and even these values we regard materially too high for average conditions, although they show a rate less than one fifth that of the estimate cited by Chamberlin. It is true that the capillary and plant "cycles" are agencies which, at the time, assist in the utilization of plant food substances, but they primarily accelerate their waste and should not therefore be reckoned as "efficient factors" of secular maintenance of soil productivity.

We quite agree that the Mongolian races have "demonstrated one mode of effective secular maintenance of the soil productivity," but we fail to see that it is "closely analogous to the natural method of the geologic ages." Our observations bring the conviction that they return to their fields, year by year, a full measure of all potassium and phosphorus removed with their crops; that their cultural methods very largely reduce losses by both physical and chemical erosion; and that they secure a very high efficiency for the plant food used by the crops. All human and animal excreta and all fuel ashes of country and city are universally applied to the cultivated fields. Enormous quantities of bean, rape seed, cotton seed and peanut oil cake are used as fertilizers annually and an enormous tonnage of canal, reservoir and river mud is also applied, even to the extent of 70 to 100 tons per acre in some instances, as single dressings which must carry to the fields not less than 100 to 150 pounds of phosphorus. Then their very extensive practise of irrigation adds, with the silt and soluble plant food carried in the water, quite as much fertility as is removed by leaching, and all irrigated areas are placed

under conditions which practically eliminate surface erosion. Both canal and reservoir mud, together with soil and subsoil, are fermented with organic matter to be used as fertilizers to an extent which would appear to western nations impossible. Indeed it appears probable that as much labor and time are spent in specific fertilization of the fields as in seeding and harvesting the crops.

While these people, so far as we can learn, have never used rock phosphates or potash salts taken from mines, as western nations are doing in recent years, they have in effect done so to a remarkable extent through their home manufacture with their compost methods. So far as we could discover they have nowhere developed or applied systems of tillage looking specifically toward physical amelioration, as such, for their soils but they have practised the culture of legumes as a source of nitrogen very systematically, persistently and extensively. Feed and water the crops is written on every field in China and Japan. Japan is now beginning to import notable amounts of commercial fertilizers and during the years 1906 to 1908 the total import of all kinds aggregated 1,427,658 tons, with a cash value of $55,423,394 and all applied to about 21,000 square miles of tilled land, constituting a tax of more than a dollar per capita for the entire population, and this is paying for an addition to an already enormously large yearly fertilization.

But the one factor which is probably equal in importance to all others is the extreme personal attention and care bestowed upon the crops, made possible and necessitated by the dense population and increasingly smaller holdings. But this has not and can not supplant their supplemental irrigation and their plant feeding except through a smaller annual output. It must be this factor coupled with the increasing larger return to the fields of plant food which has given rise to the increase in yield during recent years in this country and in Europe, to which attention has been called. It is clear that such increase may well be coincident with a decreasing plant-food content in soils of the stronger type and for the simple reason that great care may augment the rate of production of the plant-food content of film moisture for a time, with a decreasing content of the basal food elements. That the oldest and most densely settled countries should show marked increase in yield is to be expected, for here is where better care pays best, where it is compelled and where it is more readily made possible because of the denser population. But it should not be ignored that the countries named are those which are largely importing feeding stuffs and fertilizers which immediately or ultimately find place in the soil, and that those who purchase and apply these have faith that they are indispensable adjuncts to better cultural methods, improved varieties and more sanitary conditions.

There were imported into the United Kingdom in 1885, 282,960 tons of oil cakes; 64,387 tons of bones and fish; 25,258 tons of guano, and 238,572 tons of mineral phosphates. In addition, some 300,000 tons of Thomas slag are manufactured annually and largely used at home. During 1861–65 there was a mean annual importation of 1,277,778 tons of grains and beans, besides wheat. During 1901–05 importation had increased to an annual mean of 4,641,204 tons. A mean of these values may be taken, together with the fertilizers named, as a low measure of the annual importation of plant-food substances into the United Kingdom during the past twenty or thirty years.

As a rough approximation, it may be said that 2,000 pounds of the products named will contain:

	N lbs.	P lbs.	K lbs.
Oil cakes	120	18.8	30
Bones and fish	80	170	
Guano	70	170	
Mineral phosphates		250	
Thomas slag		160	
Grains and beans	50	8	12

The arable lands of the United Kingdom aggregate 19,528,000 acres and there are 28,-267,000 acres of permanent pasture.

On the basis of the amounts named the

annual importation of the three plant-food elements, including that in 150,000 tons of Thomas slag, would be:

	N tons	P tons	K tons
In oil cakes	16,977	2,660	4,244
In bones and fish	2,575	5,472	
In guano	884	2,147	
In mineral phosphates .		29,821	
In Thomas slag		12,000	
In grains	73,987	11,838	17,757
Total	94,423	63,938	22,001

To these amounts should be added the heavy importations of nitrate of soda and of potash salts.

The phosphorus content of these importations is sufficient to apply 6.54 pounds to each acre of arable land in the United Kingdom and this amount is all that is carried in the grain and straw of 20 bushels of wheat. During the twelve years preceding 1906 there was an importation of potash salts sufficient to carry 99,426 tons of potassium, which, added to the above, aggregates enough for 13 pounds per acre of the arable land. Through more than a century increasingly larger importations of fertilizers and feeding stuffs have been going into all of the countries of western Europe. These annual additions of soluble plant food elements to the film moisture and to the interior of the soil granules can not fail to exert cumulative effects upon both microscopic and higher plant life, which together must react upon yields continuing their increase until available soil moisture and then standing room become the limiting factors.

The increase in yield in the United States to which attention has been called is certainly associated with the importation of feeding stuffs and fertilizers, and while better cultural methods, better seed, better strains and fuller control of fungus diseases are responsible for some of these increases, the addition of plant food must play a large part now in the older states, especially in the North and South Atlantic groups where fertilization has been so long and so extensively practised. In the northern group, $15,641,995 and in the southern, $22,732,670 were paid for fertilizers in 1899 and applied to less than 24,683,365 and 29,194,361 acres, respectively, the amount of land in all crops that year. To give expression to these figures in terms of plant-food elements and crop yields, the mean value and composition of twelve "complete"[4] fertilizers may be used, worth $23 per ton and containing 33 pounds of N and K and 88 pounds of P. On this basis the fertilizer purchased would contain sufficient phosphorus for 2.42 pounds for every acre under crop in the North Atlantic states and for 2.98 pounds in the South Atlantic states. These are the amounts of phosphorus contained in the grain and straw of 7.5 bushels of wheat and 10.5 bushels of corn in the first case and in the second case, 9.31 bushels of wheat and 13.0 bushels of corn. But in the most thickly settled states the amounts of fertilizer used are much above the average, Rhode Island using sufficient to carry 10.2 pounds of phosphorus to each acre in crop; Connecticut, sufficient for 6.5 pounds; New Jersey, for 6.39 pounds; Massachusetts, for 6.37 pounds, while the District of Columbia is credited with fertilizers sufficient for 26 pounds of phosphorus and of 10 pounds of potassium per acre in crop, added to her cultivated soils each year.

There never has been doubt regarding the truth embodied in the statement, "that therefore there must be some efficient natural process for the maintenance of soils," but because of its association with other statements there is danger that it may be taken explicitly to mean, that therefore there must be some efficient natural process for the maintenance of soil productivity capable of sustaining, in the United States, 2,000 million people with relatively little greater effort at curtailment of waste or of return of essentials to the soil than is now practised here. If all that the Chinese and Japanese farmers are doing, and for centuries have felt compelled to do, are to be included in the "some efficient process," then all danger of misleading will be removed, for there has long been more applied science in the agriculture of "oriental experi-

[4] Hopkins, "Soil Fertility and Permanent Agriculture," p. 157.

ence" than has yet been explained or suggested by "western scientific research."

It never can be too strongly emphasized that, granting suitable climatic and physical soil condition, the fundamental of crop production is crop feeding, and that crop hunger (and thirst) has been the prime condition determining reduced yield oftener than any other. These have been the tenets of practical men through all the past and are likely to remain so to the end. Disease, parasitism, phagocytism, degeneration of seed, toxic substances or what not may at times reduce yields and the advance of knowledge which shall make it possible to diagnose these cases and apply the proper remedy, for each will augment the efficiency of plant food but make the demands for it greater nearly in proportion to increase of yield, and will accelerate soil exhaustion where nature or man makes inadequate return.

It is difficult to see on what basis of knowledge one may contend that the increase in the productivity of soils of western Europe, referred to as occurring in recent years, has been due to improvements along any of these minor lines rather than to better physical soil condition and to the increasing application of the three most essential plant-food elements which have certainly been coincident with these increases of yield; and even more difficult does the case become when referred to the long and high maintenance of soil productivity in China where plant feeding has been the heaviest burden of the people.

F. H. KING

MADISON, WIS.

A KINETIC THEORY OF GRAVITATION

TO THE EDITOR OF SCIENCE:

Imagine a pound-weight of iron raised from the surface of the earth to a point near the moon, the point so chosen that the opposing attraction of the earth and the moon shall exactly balance each other. In the surface of the earth the pound-weight had some so-called "potential energy of position" because it was capable of falling into a pit: but in its new position near the moon this potential energy has disappeared entirely; the pound-weight, left free to move, remains stationary. We can not believe that the whole or any part of it [the energy] has been annihilated: it must, in some form, be resident somewhere. I believe it was absorbed by, and is now resident in, the ether through which the weight was raised. Conversely if this be true, a falling body must acquire its energy from the ether through which it falls."[1]

Since the ether is as yet a hypothetical substance, postulated to explain certain physical phenomena, it may be allowable in discussing some phenomena to postulate its non-existence. We do not know that if the ether were non-existent and only an imaginary substance, that gravitation would also be non-existent. Assuming the non-existence of ether, but gravity acting as usual, would not the pound-weight act just as is described by Dr. Brush?

Consider a simple case. A ball weighing one pound is lifted five feet from the floor, and placed on a shelf. It has a potential energy of five foot-pounds, with reference to the floor, but it can not exert this energy, or convert it into kinetic energy, for it is prevented by the shelf. So if the ball is raised to the point near the moon, it has 20,000,000 foot-pounds of potential energy, referred to the earth, and this energy could be made kinetic, if the body were "free to move," which it is not; it is restrained by the attraction of the moon, just as it was restrained by the shelf. Suppose the ball is of iron, and that on being raised five feet it comes within the field of attraction of an electromagnet which attracts it and prevents it falling to the floor. It has five foot-pounds of potential energy, just as it had on the shelf, but it is for the time being unavailable. Let the current which actuates the electromagnet be interrupted for a fraction of a second, the ball begins to fall and the potential energy becomes kinetic. In neither of these cases has the potential energy "disappeared entirely," it has only been rendered unavailable by the attraction of the moon or the electromagnet, or by the shelf. It has not been annihilated nor is it "resident in the ether."

[1] Extracts from an article, "Kinetic Theory of Gravitation," by Charles B. Brush, SCIENCE, March 10, 1911.

The ball, the earth and the moon are portions of matter, one of the fundamental entities, or primary concepts (defining concept as that of which the mind thinks, and not an action of the mind). Gravitational attraction, a force, whether a push or a pull, is also a fundamental entity. Energy, velocity, work, etc., are complex concepts, or mathematical expressions, involving two or more simple concepts, such as, matter, space, time and force, besides the concepts of condition, such as direction, relative position and availability. The potential energy of the ball on the shelf is not merely five foot-pounds, it is five foot-pounds relative to the position of the floor, and it is not available until it is rolled off the shelf.

Consider a one-pound ball held in the hand five feet above the floor of a railroad car which is traveling eastward at the rate of 32 feet per second. It has 5 foot-pounds of potential energy and zero kinetic energy relative to the floor of the car, and $\frac{1}{2}MV^2 \equiv 16$ foot-pounds of kinetic energy relative to the earth. If it is thrown westward at the same velocity that the car is moving eastward, it has zero velocity and zero kinetic energy relative to the earth, but 16 foot-pounds of kinetic energy relative to the car, and it is capable of breaking the window in the door of the car if thrown against it.

If Dr. Brush's kinetic theory of gravitation depends on the hypothesis that the potential energy of a body raised from the earth's surface and held by the attraction of the moon (or of a magnet) disappears entirely and becomes resident in the ether, it is not likely to meet with acceptance.

There seems to be another weak point in his theory, viz., he assumes that the long radiant waves of ether, the hypothetical cause of gravitation, "pass freely through all bodies," and yet that they cast a "shadow." These two ideas seem to be inconsistent. A perfectly transparent glass plate casts no shadow of light when rays of light pass freely through it.

William Kent

Montclair, N. J.,
April 3, 1911

WHAT IS THE GENOTYPE OF X-US JONES, 1900, BASED UPON A SPECIES ERRONEOUSLY DETERMINED AS ALBUS SMITH, 1890?

Statement of Case.—Jones proposes the new genus *X-us,* 1900, type species *albus* Smith, 1890.

It later develops that *albus* Smith, 1890, as determined by Jones, 1900, is an erroneous determination.

What is the genotype of *X-us,* 1900; *albus* Smith, 1890, or the form erroneously identified by Jones as *albus* in 1900?

Discussion.—The nomenclatorial problem expressed in the caption of this note is solved in two diametrically opposite ways by different authors.

Some writers maintain that the original *albus* Smith, 1890, is the genotype, while others maintain that the genotype is represented by the species actually studied by Jones and misdetermined as *albus* Smith.

Cases of this general nature have given rise to considerable confusion in nomenclature, and several such cases have been referred to the International Commission on Nomenclature for opinion.

At the last meeting of the commission, the principles involved came up for discussion, but it was impossible to reach a unanimous agreement. On account of the differences of opinion, the secretary was instructed to make a careful study of a number of cases, and to report upon the same to the commission.

It is not difficult to foresee that no matter how the cases are finally decided, great dissatisfaction will arise among zoologists because the opinion rendered is not the direct opposite of what it eventually will be.

Recognizing that this is one of the most difficult cases that has ever been submitted to the commission, and recognizing the fact that regardless of our action we shall probably be criticized more on basis of our decision on this case than because of any other opinion that we have rendered, I am desirous of studying at least one hundred cases if possible, that

would come under such a ruling, before my report is formulated.

In view of the foregoing premises, I respectfully request zoologists in different groups to call my attention to as many instances of this kind as possible, with which they are acquainted in their different specialties. Further, since the arguments on both sides of the problem appear to be almost equally valid, it does not seem impossible that the final decision will have to be based upon an arbitrary choice between the two possible rulings, and on this account I am desirous of obtaining all possible arguments on both sides as they occur to different zoologists, and also any personal views based upon convenience or inconvenience, or other grounds, which may be held by different colleagues.

I will hold the case open at least until September 1, for the presentation of arguments by any persons who may desire to submit their views.

C. W. STILES,
Secretary of the Commission

April 4, 1911

SCIENTIFIC BOOKS

Diseases of Economic Plants. By F. L. STEVENS, Ph.D., and J. G. HALL, M.A. New York, The Macmillan Co. 1910. Pp. 313, 214 figures. $2.00 net.

The authors of this work have sought to produce a book on plant pathology "for those who wish to recognize and treat diseases without the burden of long study as to their causes." To this end "technical discussion is avoided in so far as is possible," and "no consideration is given to the causal organism except as it is conspicuous enough to be of service in diagnosis, or exhibits peculiarities, knowledge of which may be of use in prophylaxis." Non-parasitic diseases are omitted, except a few of the most conspicuous.

The volume opens with short chapters on the history of plant pathology, the damage done by plant diseases, their symptoms, prevention or cure, public plant sanitation, fungicides, spraying machinery, cost of spraying, profits from spraying, soil disinfection and general diseases.

The greater part is given to brief descriptions of plant diseases due to bacteria or fungi with suggestions regarding their prevention or cure. For this purpose a grouping by hosts is adopted; viz., pomaceous fruits, drupaceous fruits, small fruits, tropical fruits, vegetable and field crops, cereals, forage crops, trees and timber and ornamental plants. This is a commendable feature for a practical reference book as some such classification is much to be preferred to an arrangement according to the botanical relationship of the parasite.

To present in a popular way a highly technical subject and to retain accuracy and thoroughness is a much harder task than writing for professional readers. Diverse opinion exists as to the most effective method of presenting such a subject. It is, therefore, to be expected that many readers will differ with our authors. Their attention will first be arrested by the general use of *ose* as an ending for the generic name of the causal fungus to form a common name for the disease. Decay due to blue mold becomes "penicilliose"; dry rot of sweet potatoes, "lasiodiplodiose"; wilt of cotton, "fusariose," etc. There are many arguments against such names, and it does not seem wise to attempt to introduce them into a popular book before they have been accepted by plant pathologists.

Some readers will not approve the omission of all technical details relating to the nature and life history of fungi, holding them to be as essential to pathology as mathematics to a treatise on engineering. The short chapter on fungi in the appendix is not adequate nor is it correlated with the chapter on pathology.

It is to be regretted that it was found necessary to limit the book to diseases due to fungi and bacteria, especially since the causes of diseases are not given prominence in the text. The lay reader will be confused by the omission of the physiological fruit spot of the apple, while the similar but less important fungus fruit spot is discussed. Potato tipburn is given four lines while the no more important potato scab is allotted four pages of text. The wilt and dieback of the orange are omitted as is the curly top of beet, one of the

two most important maladies of that crop. That the viewpoint of the author is that of parasitology rather than pathology is further shown by the omission of any discussion of the physiology of disease. The very brief appendix chapter on physiology has no relation to the rest of the book.

From the standpoint of the lay reader it is feared that the space devoted to remedial measures is in most cases not sufficient, nor the recommendations as definite and specific as the needs of practise require.

The large number of minor diseases mentioned without adequate description will also confuse the inexperienced student.

Some more serious errors occur. The reviewer knows of no warrant for the statement on page 445 that *Microsphæra alni* practically destroys the pecan crop in the south in certain years. This fungus is one of the least harmful of the pecan parasites. Stigmonose of carnation is not mentioned while there is a reference to a more obscure bacterial disease. The discussion of mosaic disease of tobacco and tomato would be cleared by including Woods's results.[1]

Absurdly large losses are attributed to cotton anthracnose in Georgia, and the injury to tomatoes from *Phytophthora* is overstated. The description of Bordeaux injury is incorrect, as is also the statement that blossoms are killed and the lives of bees endangered by spraying with Bordeaux.

All workers in plant pathology should possess this book and it will be useful to farmers, fruit growers and all who are interested in growing plants. There has long been urgent need for a treatise on American plant diseases adapted to general readers, in which the widely scattered and often unobtainable recent publications should be summarized. This book is intended to meet this need.

W. A. Orton

Preliminary Report on the Peat Deposits of Florida. By Roland M. Harper. Third Ann. Rept. Fla. Geol. Surv., 1910, pp. 197–375, pl. 16–28, tf. 17–30.

[1] Bulletin 18, Bureau of Plant Industry, 1902.

The state of Florida because of its flatness, its abundant ponds, lakes and swamps, its ample, well-distributed rainfall and the absence of sediment-laden streams, affords exceptionally favorable conditions for the formation of peat, and the present report is a monumental disproof of that ancient and persistent fallacy that peat is formed only in high latitudes.

For purposes of discussion the state is divided by the author into fourteen more or less natural divisions based chiefly upon topography and vegetation, and these are shown on a sketch map. The varied swamps of the state are elaborately classified, more than thirty types being enumerated and described in more or less detail. The more common plants of each are listed in the order of their abundance.

A few pages are devoted to fossil peat. Numerous analyses of peat samples are given and there is a chapter upon the utilization of peat. This is followed by a reliable systematic catalogue of Florida peat-forming plants and the report is concluded by a bibliography and a good index.

The report, as a whole, is well done and excellently illustrated by 13 plates and 14 text-figures. While it is confessedly superficial, it should be remembered that the economic development of Florida at the present time would hardly warrant the investment of the large sum of money necessary for an exhaustive study of its peat deposits. From the commercial view point the present report is surely ample enough to point the way to a utilization of the more important peat deposits and those which are favorably situated for exploitation.

Dr. Harper approaches the subject from the view point of the plant geographer, and it is this aspect of the report which has the most scientific merit and which will occasion the widest interest. A more intensive study and a much fuller treatment of the flora would have been desirable from the standpoint of the botanist, but for the reasons mentioned above such a study was not practicable.

The report is weak in its discussion of fossil peat, only two or three occurrences being briefly mentioned. It is very probable, however, that there are no deposits of this sort in the state which are not too small or too deeply buried to be of commercial value. At the same time, the reviewer's experience in the southern states shows that Pleistocene or older peats are more wide-spread, if not more extensive individually, than recent peats, and their botanical records are often of the greatest value. For example, such a deposit just across Perdido Bay from Florida contains not only ancestral forms of *Nyssa, Hicoria* and live-oaks, but abundant remains of the genus *Trapa,* which is unknown in the existing flora of the western hemisphere.

EDWARD W. BERRY

JOHNS HOPKINS UNIVERSITY

NOTES ON ENTOMOLOGY

AMONG the recent parts of the "Catalogus Coleopterorum" are part 19—Staphylinidæ (1), by A. Bernhauer and K. Schubert; part 20—Aphodiinæ, by A. Schmidt; 21—Gyrinidæ, by K. Alwarth; 22—Tenebrionidæ (2), by H. Gebien; 23—Cleridæ, by S. Schenkling; 24—Histeridæ, by H. Bickhardt; 25—Cebrionidæ, by K. W. von Dalla Torre, and 26—Scraptiidæ and Pedilidæ, by M. Pic.

A NEW French entomological journal is *Insecta, Revue Illustrée d'Entomologie,* published by the entomological station of the faculty of sciences of Rennes, F. Guitel, editor. It is a monthly, and the first number contains articles on orthoptera, coleoptera and economic entomology; all the systematic articles are illustrated.

THE peculiar larval cases of the Cryptocephalidæ and the remarkable larvæ of the Cassidæ with their highly modified tails have always been entertaining subjects with coleopterists. Mr. Karl Fiebrig has added greatly to this interest by his article on these insects.[1] The life history of a number of South American species is given more or less completely, and the plates (partly colored) illustrate many details of structure.

MR. A. M. LEA is the author of an interesting article on the beetles occurring in ants' nests in Australia and Tasmania.[2] Although the paper is a systematic one, there are notes on the habits and occurrence of many of the species. Most of the species belong to the Pselaphidæ; many are new; there are 23 species of *Articerus* and 14 of the curious long-legged Histerid—*Chlamydopsis.* A new family is based on a new genus, *Tretothorax,* placed between the Rhysodidæ and Cucujidæ; the mouth-parts are entirely concealed by the broad mentum, the hind tarsi four-jointed, the others five-jointed; it is a slender insect, with short and broad antennæ.

THE first part of the work on the aquatic flies of Germany is issued, the author being Dr. K. Grünberg.[3] This part includes all the diptera with aquatic larvæ except the Chironomidæ, which will be treated in the second part. There are synoptic tables to the genera and species and in many cases to the genera of the larvæ as far as known. Since many of the genera and a number of the species also occur in the United States, the book will be of considerable use to Americans. The arrangement of the Culicidæ is that generally followed a few years ago.

THE twenty-fourth lieferung of "Das Tierreich" is on the hymenopterous gall-flies (Cynipidæ), and is by Dr. K. W. von Dalla Torre and Professor J. J. Kieffer; 891 pages, 420 figs. About 1,200 species are treated; the genera are used in a broad sense, many recent segregates being sunk as synonyms, or subgenera. Tables are given for the galls of the old and new world. In the back is a list of genera, with references, derivation and originally included species.

[1] "Cassiden und Cryptocephaliden Paraguays, irhre Entwicklungsstadien und Schutzvorrichtungen," *Zool. Jahrb. Supp.,* 12, heft 2, pp. 161–264, 5 pls., 1910.

[2] "Australian and Tasmanian Coleoptera Inhabiting or Resorting to the Nests of Ants, Bees and Termites," *Proc. Roy. Soc. Victoria,* XXIII., pp. 116–230, 3 pls., 1910.

[3] "Die Süsswasserfauna Deutschlands," Heft 2A, Diptera, Jena, 1910, pp. 312, 348 figs.

The November-December number of the Hungarian entomological journal—*Rovartani Lapok*—is a jubilee number in honor of Alex. Mocsary, for his forty years' service in the Hungarian National Museum. Most useful is a list of his numerous publications. A list of species (65 in all) that have been named in his honor is given, to which various friends add new species in all orders in this number of the journal.

Mr. C. C. Ghosh has published an account of the life-history of a neuropterid fly—*Croce filipennis*.[4] These delicate insects are but little known, and a figure of Savigny had long done duty as the only known larva of the family. The larva of *Croce* is very similar to that of Savigny, with a large *Chrysopa*-like head and jaws and an extremely slender prothorax; the abdomen broad and flat. They live in houses in India, and feed on silver-fish and bed-bugs. The pupa is formed within a spherical cocoon; the larval stages last for nearly a year, and the adult appears for only a few days in April.

Dr. E. Mjoberg is the author of a long article on morphology and classification of the biting and sucking lice.[5] A number of species are described as new, mostly from the old world, and several new genera. One, *Neohœmatopinus*, is made for *Hœmatopinus sciuropteri* Osborn. He concludes that both Anoplura and Mallophaga should be included with the Psocidæ in the Corrodentia, as three subequal groups; the Anoplura more closely related to the Mallophaga than either to the Psocidæ. A useful bibliography is appended.

Carl Henrich has published a large paper on German plant-lice which will be of use to our students of these insects.[6] He divides the family into the usual six tribes, but appears to be unfamiliar with some of the recent generic changes.

Dr. N. J. Kusnezov brings up cases of probable viviparity in certain pierid butterflies of northern Russia.[7] In examining the anatomy of certain pierids (*Colias*) he found fully developed larvæ in the lower part of the oviduct, and no chlorion around them. These larvæ were bent double, with the head toward the aperture. He therefore concludes that at least sometimes the larvæ are born alive, or at least so far advanced that the eggs hatch very soon after deposition. The reason for this intrauterine development of the embryo he believes is the short season in the northern localities. Two species of Tineids have been recorded as viviparous.

Nathan Banks

SPECIAL ARTICLES

PROTECTIVE ENZYMES[1]

In this preliminary paper the authors will bring together the results which thus far show some important relations and reactions carried out by certain protective enzymes of fruits. This work originated in the efforts of one of us (Cook) to determine the toxicity of tannin. It is well known that tannin is one of the most abundant of plant products, and it has been repeatedly stated that it occurs in green fruits. Although the work referred to above gave very definite results on the toxicity of tannin, it became evident that there was some factor or factors in the living fruit which had not been taken into consideration, making it necessary to attack the problem from the biochemical standpoint.

Pomaceous fruits were most satisfactory for our purpose, although the fruit of the tomato and other plants were also used. As the work progressed many difficulties presented themselves, such as the uncertain and more or less unreliable methods for quantitative determination of tannin.

[4] *Journ. Bombay Nat. Hist. Soc.*, 1910, p. 530.

[5] "Studien über Mallophagen und Anopluren," *Arkiv f. Zoologi*, Vol. VI., No. 13, 296 pp., 5 pls., 1910.

[6] "Die Blattläuse, Aphididæ, der Umgebung von Hermannstadt, mit einem Index und Figurenerklarung," *Verh. Mitt. Siebenb. Ver. f. Naturwissensch. zu Hermannstadt*, LIX., pp. 104, 1 pl., 1910.

[7] "On the Probable Viviparity in some Danaid, *i. e.*, Pierid Butterflies," *Hor. Soc. Ent. Ross.*, XXXIX., pp. 634–651, 1 pl., 1910.

[1] By permission of the Delaware Agricultural Experiment Station.

Among other things brought to light by these studies was the very great variability in the amount of tannin at different times and under different conditions. It is well known that tannin occurs in great abundance in certain tissues of the plant and in injured parts, and these facts led to original studies on the possible function of tannin in plants. However, we did not expect to find the great variation in amount of tannin dependent upon the length of time between the removal of the fruit from the tree and the analysis of this same fruit, for it was finally learned that there was a rapid increase in the amount of tannin or like bodies in the normal fruit immediately after removal from the plant, and that the tannin continued to increase in quantity for some time. Although the greatest increase was, as previously stated, immediately after removal from the plant.

For instance, a sample was taken by dropping the fruit into boiling water immediately after plucking to stop all enzyme action, and the tannin determined at once. At the same time another sample of the fruit on the same tree was injured by repeated puncturing of the stem and fruit with a pin and allowed to remain on the tree for 48 hours, when the tannin was determined. In the latter case the tannin was about three times as great as in the former. Apples which had fallen from the tree were also analyzed for tannin and showed about twice as much as in the case where the enzyme action was stopped if such was the cause of the action. However, it was thought that this action should be traced even further than shown in the above preliminary experiments and the first and best method that suggested itself (Thompson) was to follow the action by tracing the soluble nitrogen in content which would decrease if tannin or a tannin-like body was formed which would unite with the proteid bodies in the fruit juices. Accordingly, juices were prepared from a number of different fruits and substances where such action might occur. The materials used were green walnut hulls, ripe apples, green apples and pears; they were first ground through an ordinary meat chopper and pressed through canton flannel. These juices were sampled immediately after pressing out and every 24 hours thereafter, until fermentation was apparent, the samples being filtered through asbestos by suction, and the soluble nitrogen determined with the following results:[2]

Ripe apples—no decrease.
Green apples—64 per cent. decrease in 48 hours.
Pears—14 per cent. decrease in 48 hours.
Walnut hulls—16 per cent. decrease in 94 hours.

To further prove that the action might be due to enzyme action one sample of the above walnut juice was brought to boiling temperature and kept there 30 minutes. In this case for the first 48 hours there was practically no decrease in the soluble nitrogen, but after 94 hours it showed about 6 per cent.

In these experiments it will be noted that there was positive proof of the formation of a tannin-like body that had the power of precipitating proteid matter, thus causing part of the nitrogen to be precipitated in the insoluble form, but as yet the nature of the enzyme was not determined further than this property, although it had been previously shown that the juices had the power of decomposing hydrogen peroxide.

Therefore, a similar series of experiments were carried out by grinding the fruit with calcium carbonate, as suggested by Appleman's work on catalase, in which he showed that the activity of the catalase could be preserved by such treatment. However, when the juices were filtered off and the soluble nitrogen determined, there was no decrease in any case, but fermentation set up in about 36 hours, which was a considerably shorter time than in the previous experiments.

On allowing the calcium carbonate precipitate to settle and testing both the precipitate and the supernatant liquid with H_2O_2 by the method given by Appleman, it was shown that all of the catalase was carried down by the

[2] Complete data in "The Preparation and Properties of an Oxidase Occurring in Fruits," by H. P. Bassett and Firman Thompson, *Journ. Amer. Chem. Soc.*, 33: 416–423, 1911.

calcium carbonate and none whatever remained in the supernatant liquid. Accordingly, this precipitate was filtered off on a Buchner funnel and allowed to dry over sulphuric acid.

It is well known that tannin as such can not exist to any considerable extent in the presence of proteid matter, since these two substances form a precipitate, but as it has been shown repeatedly by the ferric chloride and similar tests that a body existed in the plant cells which gave these tests, the conclusion was drawn that this body must be poly-atomic-phenol that would not precipitate proteid matter. Accordingly, gallic acid was selected for our following experiments.

Therefore, a quintuple set of experiments were then carried on, one set with tannin, a second set with gallic acid, a third set with gallic acid plus enzyme, a fourth set with sodium gallate, and a fifth set with sodium gallate plus enzyme. The experiments were made by putting about 33 c.c. of liquid medium in each of a number of 200 c.c. Erlenmeyer flasks. The tannin, gallic acid and sodium gallate were added to the medium in the following proportions: .025, .05, .1, .2, .4, .6, .8 and 1 per cent. The amount of enzyme was constant throughout the two series in which it was used.

These experiments showed that the organism (*Cunninghamiella echinulata*) used made its best growth in the check and in the gallic acid, and the next best growth in the sodium gallate. The gallic acid plus the enzyme, the sodium gallate plus the enzyme, and the tannic acid all showed a tendency to check the growth in the lower percentages and to completely inhibit it in the higher percentages. However, the results with the next organism (*Glomerella rufomaculans*) were radically different and led to further investigations. In preparing the enzyme with calcium carbonate, as suggested by Appleman's work on catalase, it has been shown above that the precipitated calcium carbonate carried down the catalase completely, but upon testing the supernatant liquid with guiacum it was shown that the presence of an oxidizing enzyme still existed in solution. However, upon testing the precipitate with guiacum after dissolving out the calcium carbonate and acidifying, with acetic acid, it also showed that a considerable portion of this oxidizing enzyme was carried down by the calcium carbonate, and upon drying this precipitate it was shown to absolutely lose its activity. Thus in drying the catalase precipitated by calcium carbonate the portion of the oxidizing enzyme carried down with it was killed, thus explaining the marked difference, as shown above. It should be stated here that in the first experiment referred to above the calcium carbonate precipitate was not completely dry, while in the second it was quite dry. Thus in the first case a considerable amount of the oxidizing enzyme still existed and exerted its influence on the transformation of the gallic acid into the tannin-like body, while in the second case the oxidizing enzyme had been destroyed by the drying and no such action took place to any considerable extent.

It was now evident that we had two enzymes instead of one, and that they could be completely separated from each other by their properties, as stated above, but in such a large proportion of the oxidizing enzyme carried down by the calcium carbonate precipitate it became evident that methods would have to be devised for obtaining the oxidizing enzyme from the supernatant liquid. Accordingly, the supernatant liquid was drawn off and treated by the general method for enzyme precipitation, namely precipitation with alcohol (60 per cent.). This precipitate carried practically all the enzyme down with it. This was allowed to settle and finally collected on a Buchner funnel. As it had been shown that it could not be dried, it was now prepared for use by suspension in water, and in this manner used in the following experiments. The ferric chloride and other tests on the plant cell contents showed the presence of a poly-atomic phenol, and it was evident that the formation of the tannin-like body from the poly-atomic-phenol could probably be carried out in artificial solutions. However, it has been previously shown by Bertrand in work-

ing with laccase prepared from the sap of the lac-tree, and Lindet with an oxidase found in cider and wines, that these enzymes possess the property of oxidizing certain poly-atomic-phenols; *e. g.*, hydroquinone to quinone and pyrogallol to purpurogallic. Thus the following experiments were planned to study this property of the enzyme by preparing artificial solutions of gallic acid and albumen and measuring the rate and extent of the formation of the tannin-like bodies by the decrease of the soluble nitrogen.

Accordingly, 500 c.c. quantities of the following solution were prepared:

No. 1—gallic acid alone, 4 per cent.
No. 2—gallic acid and enzyme.
No. 3—gallic acid and enzyme.
No. 4—gallic acid, albumen and enzyme.
No. 5—gallic acid, enzyme and albumen.
No. 6—enzyme alone.

The albumen used was a solution of egg white which had been filtered through absorbent cotton and contained 1.36 grams of nitrogen per liter. The enzyme was prepared from pear juice by grinding fruit in calcium carbonate, pressing out the juice and allowing it to settle, drawing off the supernatant liquid and precipitating the enzyme with 60 per cent. alcohol, collecting on Buchner funnel, and suspending this precipitate in distilled water. Fifty cubic centimeters of this suspension was used in each case. A series of experiments similar in every particular except 50 c.c. of 3 per cent. hydrogen peroxide was added in each case, and was carried out in the same time. In about an hour after the enzyme had been added a very heavy flocculent precipitate had formed and settled, in those flasks containing all three constituents, viz., gallic acid, albumen and enzyme. Those containing gallic acid and enzyme without albumen had turned a rich wine red color, presumably from the oxidization of the gallic acid.

Samples of 50 c.c. each were taken after 15 hours, and every 24 hours thereafter until there was no longer any decrease in the nitrogen or until the solution showed signs of fermentation.

No. 2, containing gallic acid and albumen, showed no change in soluble nitrogen after 5 days.

No. 4, containing gallic acid, albumen and enzyme, showed a marked decrease in soluble nitrogen amounting to 70 per cent. in five and one half days, 26 per cent. being precipitate in the first 15 hours.

The corresponding solution containing hydrogen peroxide showed a similar decrease, but was considerably more rapid, amounting to 47 per cent. in the first 15 hours.

Having made this further investigation, as outlined above, thus determining some of the properties of this oxidizing enzyme and at the same time explaining our former results, it was now desirable to try the effects of this pure enzyme preparation upon certain fungi. Therefore, *Cunninghamiella echinulata, Glomerella rufomaculans, Pestalozzia breviseta* and *Penicillium aureum* were used in a quintuple set of experiments according to the method previously referred to, but using the pure oxidase instead of the calcium carbonate precipitate. In all cases there was decided action increasing with the increased amount of gallic acid or sodium gallate used.

Since the above experiment showed such high toxic effects which could not all be accounted for by the fermentation of the tannin-like body, it was decided to carry out further experiments on the germicidal properties of the solutions formed. It had also been previously noted that the juices that had been prepared by grinding with calcium carbonate, and in which there was apparently no action of the enzymes fermented much more readily than the juices that had been prepared by grinding without calcium carbonate, and it was evident that the other bodies formed in the reaction might have some germicidal properties. Accordingly, six days after the experiment with gallic acid to show that the precipitate of the soluble nitrogen had been started, plate cultures on agar-agar and gelatine were made from the solution containing gallic acid and albumen; gallic acid, enzyme and albumen; enzyme and albumen. Cultures in beef tea were also made at the same time.

Ninety-six hours after the setting of the cultures the following results were noted. In both cases where the gallic acid and enzyme were not present together there was a heavy fungus growth; but in both cases where they were present together there was a very slight growth in all media. Thus the conclusion would be that the body formed by the action of the enzyme and gallic acid had a marked inhibitive effect on fungus and bacterial growth. It was apparent that for these germicidal effects to be of any value to the fruit it would necessarily have to have quite a rapid reaction in order to keep out any chance of infection, and also from the almost instantaneous appearance of the precipitate; and from the data obtained for the transformation of the soluble nitrogen it was inferred that the action was comparatively rapid, and accordingly an experiment was planned to obtain further data on this point. A solution consisting of 100 c.c. of albumen solution, 200 c.c. of 1 per cent. gallic-acid solution, 50 c.c. of enzyme suspension, and 50 c.c. of 3 per cent. hydrogen peroxide was prepared and diluted to 500 c.c. Another solution which was the same in every respect with the exception of the hydrogen peroxide, which was omitted, was prepared at the same time. Samples of these two solutions were taken every fifteen minutes, for about two hours, and the soluble nitrogen determined. The solution could not be obtained clear on filtering and no flocculent precipitate separated out as in the previous cases. The determinations of nitrogen also showed no decrease in the soluble nitrogen. Thus it was apparent that for some reason the action was not taking place as before, but on adding 60 c.c. more of the enzyme suspension in each case, a heavy flocculent precipitate immediately formed and settled rapidly, and the first sample was taken ten minutes later, filtered as rapidly as possible, and the soluble nitrogen determined showed a decrease of 42 per cent. in the solution containing the hydrogen peroxide and 53 per cent. in the other.

The same experiment was then repeated with the constituents in the same proportions, but the quantity of the enzyme suspension was increased to 150 c.c. The flocculent precipitate appeared at once and settled immediately. Samples were taken every 15 minutes for the first hour, and at longer intervals thereafter for 4½ hours. The decrease in the soluble nitrogen amounted to about 30 per cent. in the first 15 minutes in the solution containing the hydrogen peroxide, and about 23 per cent. in the other. There was, however, practically no further change in the soluble nitrogen, up to four and one half hours, when the sampling was discontinued.

These results no doubt show conclusively that the action carried out by the enzyme is very rapid, but will take place only when the concentration is above a certain undetermined minimum, which point is of very great importance when acting as a protective agent for the fruit.

Analysis of the fruits (apples and pears) made throughout the season, where identical conditions were adhered to, showed a gradual decrease in tannin content. It is well known that fungus parasites increase in activity throughout the season and are most destructive as the fruits approach maturity. Later in the season tests were made for the determination of the localization of the enzyme in the fruit by the use of the guiacum solution, which showed that in the case of pears the blue color developed first around the core and immediately under the peel, but finally developed uniformly over the freshly cut surface. As cold weather approached, the pears were removed from the trees and stored in a cool, dry place, by which means it was hoped that the work might be continued for some time. An attempt to prepare some of the enzyme from these pears eight days after their removal from the tree resulted in a preparation which had lost practically all its power. On testing the freshly cut surface with guiacum solution no blue color was developed, excepting rather faintly immediately around the core. The supply of pears having been exhausted, apples were examined in the same manner from time to time, and showed a gradual decrease in the amount of enzyme

until to date (February 8, 1911), showing only a slight trace around the inner part of the core.

It is interesting to note that early in the season several normal fruits were injured by passing a sharp instrument through them from side to side and allowing them to remain on the tree for 48 hours thereafter. A section was then made through the injury and the guiacum solution applied. The blue color developed first quite strongly around the walls of the injury, followed gradually by the other parts of the pear.

From the preceding it will be readily seen that there exists in the normal living fruit two enzymes, a catalase and an oxidase. The latter is probably most abundant in the early part of the season, gradually decreasing in activity as the fruit approaches maturity and ripens. Furthermore, from the above results it appears that tannin as such does not exist in any part of the normal, uninjured fruit previous to maturity, except possibly a small amount in the peel, but exists as a poly-atomic phenol, which upon injury is acted upon by the oxidase and forms a tannin or tannin-like body having the property of precipitating proteid matter, and at the same time forming a germicidal fluid. This oxidase acts only in an acid solution, and when present in an amount above a certain undetermined minimum. The above conditions are always present in normal immature pomaceous fruits. When normal, immature fruits are subjected to injury by fungi, insects, or mechanical agencies, the action of the oxidase on poly-atomic-phenol is brought about with the effects as stated above.

MEL T. COOK,
H. P. BASSETT,
FIRMAN THOMPSON,
J. J. TAUBENHAUS
DELAWARE AGRICULTURAL EXPERIMENT STATION,
NEWARK, DELAWARE.

THE RELATION OF PERMEABILITY CHANGE TO CLEAVAGE, IN THE FROG'S EGG

UNFERTILIZED eggs (taken from the uterus) of the wood frog, *Rana sylvatica,* were caused to assume the normal orientation in the jelly, and to segment, by electrical stimulation. An alternating current of 60 cycles and 110 volts was passed through the tap water containing the eggs, from platinum electrodes about two inches apart. Stimulation for one second seemed to give the best results. The eggs were placed in fresh water immediately after stimulation.

Similar eggs were caused to segment by mechanical stimulation, even while the jelly remained intact. However, the most reliable mechanical means of inducing cleavage was found to be Bataillon's method of pricking the egg with an extremely fine needle. The first cleavage furrow often passed through the point of puncture.

Thousands of eggs were operated on. Control eggs were kept to both sets of experiments, and showed no segmentation or rotation within the jelly.

The following indirect evidence is given to show that a change in permeability is associated with both of these means of inducing cleavage:

1. These "stimuli," if applied in greater intensity or duration than is necessary to produce cleavage, result in rapid osmotic exchange with the medium and death of the egg.

2. Similar electrical and mechanical "stimuli" produce segmentation in the sea-urchin's egg, a process which I have shown to be preceded by an increase in permeability.

With the exception of the rate of oxidation, this change in permeability is the only known common intermediate step between fertilization or artificial "stimulation," on the one hand, and cleavage on the other. Furthermore, there is indirect evidence to show that increase in permeability is associated with fertilization, in the frog's egg, as I have shown to be the case in the sea-urchin's egg: Backman and Runnström[1] observed that, whereas the osmotic pressure (freezing point lowering) of the ripe ovarian egg of the frog is the same as that of frog's serum, the osmotic pressure of the fertilized egg is the same as that of the pond water in which it lies. Since the frog's

[1] *Biochem. Zeitschr.*, 1909, XXII., 390.

egg does not swell enormously after oviposition, it is improbable that the fall in osmotic pressure is due to the absorption of water. The simplest explanation is that the egg is, at this time, permeable to the internal osmotic substances. That this permeability is only a temporary condition is indicated by the fact that the osmotic pressure of the resulting embryo rises until it reaches that of frog's serum.

In conclusion, I wish to thank the Carnegie Institution, and especially Dr. Chas. B. Davenport, the director of the laboratory.

J. F. McClendon
Station for Experimental Evolution,
Cold Spring Harbor,
Long Island, N. Y.,
April 3, 1911

THE BACTERIOLOGY OF "TÄTTÉ MELK"

This milk is a favorite food article in Norway and Sweden and is prepared by inoculating sweet cow's milk with leaves of *Pinguicula vulgaris* or with a small amount of the finished product. Sometimes pieces of linen are dipped into the fermented milk, allowed to dry, and used for inoculation. This method makes it feasible to send the material by mail. The milk is thick and slightly stringy and has a slight cheesy taste and odor.

I obtained three samples of the milk and one of the impregnated linen from a reliable source for the purpose of determining the active agents in it. A microscopic examination of the samples showed streptococci in large numbers, mostly in diplococcus form, but frequently in chains of ten to sixteen members. Two species of yeasts were also in abundance, one being an oval yeast, the other a large organism with square ends, often forming long filaments. Besides these organisms there were present some bacilli resembling *B. coli* in shape and size, which proved to be gram-negative. There were also a few large bacilli resembling that group of bacilli, which is found in milk almost invariably and forms larger amounts of acid than ordinary lactic acid bacteria. Microscopic examination of the impregnated linen did not show yeast cells.

Plates were prepared from the four samples in dextrose-litmus-agar and in beerwort agar; litmus milk was inoculated with the original material. The milk, when intended for consumption, is inoculated at body temperature, and therefore all plates and cultures were incubated at 37° C.

There was no difficulty in isolating the different organisms from the plates. The streptococcus could not be distinguished microscopically from *S. lacticus,* but its action on sterile milk differed in that it coagulated but slowly; after coagulation the coagulum was stringy, similar to the coagulum formed by *B. bulgaricus,* but in a smaller degree. The oval yeast gave the microscopic picture of *Saccharomyces cerevisiae.* It ferments lactose and saccharose with violent gas production, levulose slowly, and maltose not at all. Cultures of this yeast in liquid beerwort impart a somewhat stringy consistency to the medium. The other yeast proved to be *Oïdium lactis,* which is always present in milk and in this milk is probably responsible for a slight cheesy taste and odor.

Cultures of the samples were also made in broth with the addition of 2 per cent. dextrose and 0.5 per cent. acetic acid. The presence of the acid restrains most bacteria, so that those forming a large amount of acid can be detected by this method. Dextrose also favors the growth of these bacilli. After twenty-four hours' incubation they were found in abundance in the cultures. These organisms, however, do not multiply readily in milk in competition with other bacteria and I do not believe that they have any bearing upon the production of "Tätté Melk." In fact sterilized milk, inoculated with streptococci, isolated from the samples, and with the two species of yeasts, resembled the original product closely after twenty-four hours. Whether the yeast has anything to do with the stringiness of the milk is doubtful, but it adds to the palatability of the milk. It does not produce nearly as much gas in the milk as it does in pure culture.

P. S. Heinemann
University of Chicago

PERMIAN REPTILES

THE relationships of the South African and American Permian faunas have long been of profound interest, from both the geological and evolutionary standpoints. Students have now generally come to an agreement in the union of all the Permian and Triassic stegocrotaphic reptiles (exclusive of the Chelonia) under the single order Cotylosauria, but, until recently, the zygocrotaphic terrestrial reptiles have been distinguished under five or six ordinal names, though Broom is willing to unite the African forms under the ordinal or superordinal term Therapsida.

Within the past few years, beginning with the important collections made by Professor Case, the University of Chicago has acquired a very rich representation of the American Permian reptiles and amphibians, some six or seven of the thirty odd genera acquired represented by practically complete skeletons. Among the latest of these collections, discovered the past year by Mr. Paul Miller in the vicinity of Seymour, Texas, is a very nearly complete articulated skeleton of the remarkable genus described a few years ago as *Seymouria* by Broili, from two incomplete skulls. Almost nothing of the remainder of the skeleton has hitherto been known. Within the past year I described and figured a considerable part of a skeleton of a very small reptile, based upon two specimens of nearly identical size, under the name *Desmospondylus,* suggesting at the time the possible identity with either *Seymouria* or *Pantylus.* The name proves to be a synonym of *Seymouria.* Although the two specimens described are scarcely a third of the size of the adult, and both of the same size, they doubtless are juvenile, or embryonic. I also suspect that *Conodectes* Cope is the same genus, or at least is a closely allied genus; but the name is unworthy of priority, since the type was never really described or figured.

Seymouria presents such extraordinary characters, that, if we raise the Diadectidæ, Pariotichidæ and Pantylidæ to subordinal rank, as would be justified from the characters used to distinguish the South African groups, we must also elevate the Seymouriidæ to the same rank. I am, however, opposed to the erection of so many ordinal names; they are in large part merely confessions of ignorance. The family Limnoscelidæ, for instance, recently described by me from the Permian of New Mexico, shows certain intermediate characters between the Diadectidæ and Pareiasauridæ. For the present, it seems to me that the following classification will suffice: Order Cotylosauria, families Diadectidæ (Nothodontidæ Marsh), Limnoscelidæ, Pariotichidæ, Seymouriidæ, Pantylidæ, Pareiasauridæ and Procolophonidæ, the last two exclusively African and European, the others exclusively American.

And I would go still further; possibly some will think too far. The possession of a very perfect skull of *Edaphosaurus,* hitherto known from imperfect material only, convinces me that Broom is right in his acceptance of the views previously held by Cope, but which for some years have fallen into desuetude, that the African and the American therocrotaphic reptiles (that is, those with a lower temporal vacuity only) are likewise related in the same way and perhaps in the same degree. Broom would still retain their ordinal distinction, but I am disposed to go further and reunite them under the name originally applied by Cope to the Pelycosauria and Anomodontia—Theromera or Theromorpha. The working out of the genus *Casea,* recently described by me, has disclosed many aberrant characters, separating the genus more widely from the Pelycosauria than are any two groups of Broom's Therapsida. But, I repeat, I am not willing to make so many new orders; it serves no useful purpose; and both *Edaphosaurus* and *Casea* would require ordinal distinction if we accept the groups of Therapsida as orders. I therefore propose the following classification of the therocrotaphic reptiles (excluding the Theriodontia): order Theromera; suborders Pelycosauria, Poliosauridæ, Edaphosauridæ, Caseidæ, Aræoscelidæ (?), Therocephalia, Anomodontia, Dinocephalia and Dromasauria, the first five American, the others African. I leave the

family termination to some—one can do what he chooses with them. S. W. WILLISTON

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 691st (40th anniversary) meeting was held on March 11, 1911, President Day in the chair. The evening was devoted to hearing the annual address of the retiring president, Mr. R. S. Woodward, who spoke of the "Meaning of Research."

The speaker mentioned the importance of the time element in measuring progress in research, and stated that we are often prone to measure progress by months and years instead of decades. As a study of the society may throw some light on the meaning of research, the speaker briefly reviewed the great work the Philosophical Society, which is yet young, has done, what it is for and what it may do.

The society has had thirty-two presidents, of whom the speaker had known all except two, and he had worked with two thirds of them. The chief work of many of these were mentioned. Forty years ago was a time of profound intellectual agitation, the principal cause of which was Darwin's "Origin of Species," and it is probable that the Philosophical Society was due to the great influx of new ideas coming at that time. Stirring intellectual enterprise (not repose) was the order of the day. At that time biology was the most conspicuous sign of the intellectual uprising; the work of Kelvin and Tait, and Maxwell was not more revolutionary than Darwin's. Progress has since been at an accelerated rate. Applications of results of physical science have multiplied ten to one hundred fold.

The development of scientific work by the government was described at some length, mention being made of a number of departments and individuals therein that have contributed to both practical and theoretical results in many branches of science, including medicine, most of which had been done by members of the Philosophical Society. The characteristic features of research by members of the society during these years were mentioned.

Research has not been understood by the masses, and has not generally been recognized as a vocation. The methods of science are now coming to be recognized by all as the best method for the discovery of truth. The meaning of research is best recognized by the fruits of this and other similar societies.

The chair expressed the thanks of the society to the speaker for his excellent address. The address will soon appear in full in a bulletin of the society.

THE 692d meeting of the society was held in the new auditorium of the National Museum on March 25, 1911, this being a joint meeting with the Washington Academy of Sciences. The evening was devoted to hearing an address by Dr. Svante Arrhenius, by invitation, on the subject of "The Atmosphere of the Planets."

The constitution of the sun and its probable temperature were briefly mentioned. Owing to its gaseous condition the specific gravity of the sun is about one fourth that of the earth, that of Jupiter and Saturn being about the same as that of the sun. The majority of the planets are void of an atmospheric envelope. The moon's atmosphere is about one thousandth that of the earth.

The critical velocities of bodies at the earth and at the moon were mentioned. In speaking of the critical velocities of various substances at the moon it was stated that hydrogen and helium had long ago flown off from the moon.

The minor planets, lying in orbits between the sun and Mars, have no atmosphere. Mars, Venus and the earth only, have an atmosphere. Venus has a very heavy atmosphere and which is now like that of the earth ages ago.

Laplace's theory of the extension of the sun's gases to Neptune and Uranus was mentioned.

The question of how the earth got its present atmospheric properties was discussed. When the temperature of the earth reached 55° C. organisms could live. The polar regions of Venus are about 60° C. and organisms may live there.

In discussing the important function of the existence of CO_2 in the atmosphere, it was stated that the time will come when the amount of it will dangerously decrease, and finally all of it and some of the water will go from the earth, the earth will grow colder and the rest of the water will freeze.

Mars is now a desert with a low temperature, its atmosphere is about one twentieth that of the earth. This will nearly all vanish, especially when the sun's radiation allows Mars to cool down. This is the fate of all planets.

President Day, of the Philosophical Society, thanked the speaker, on behalf of the joint meeting, for his very interesting address.

R. L. FARIS,
Secretary